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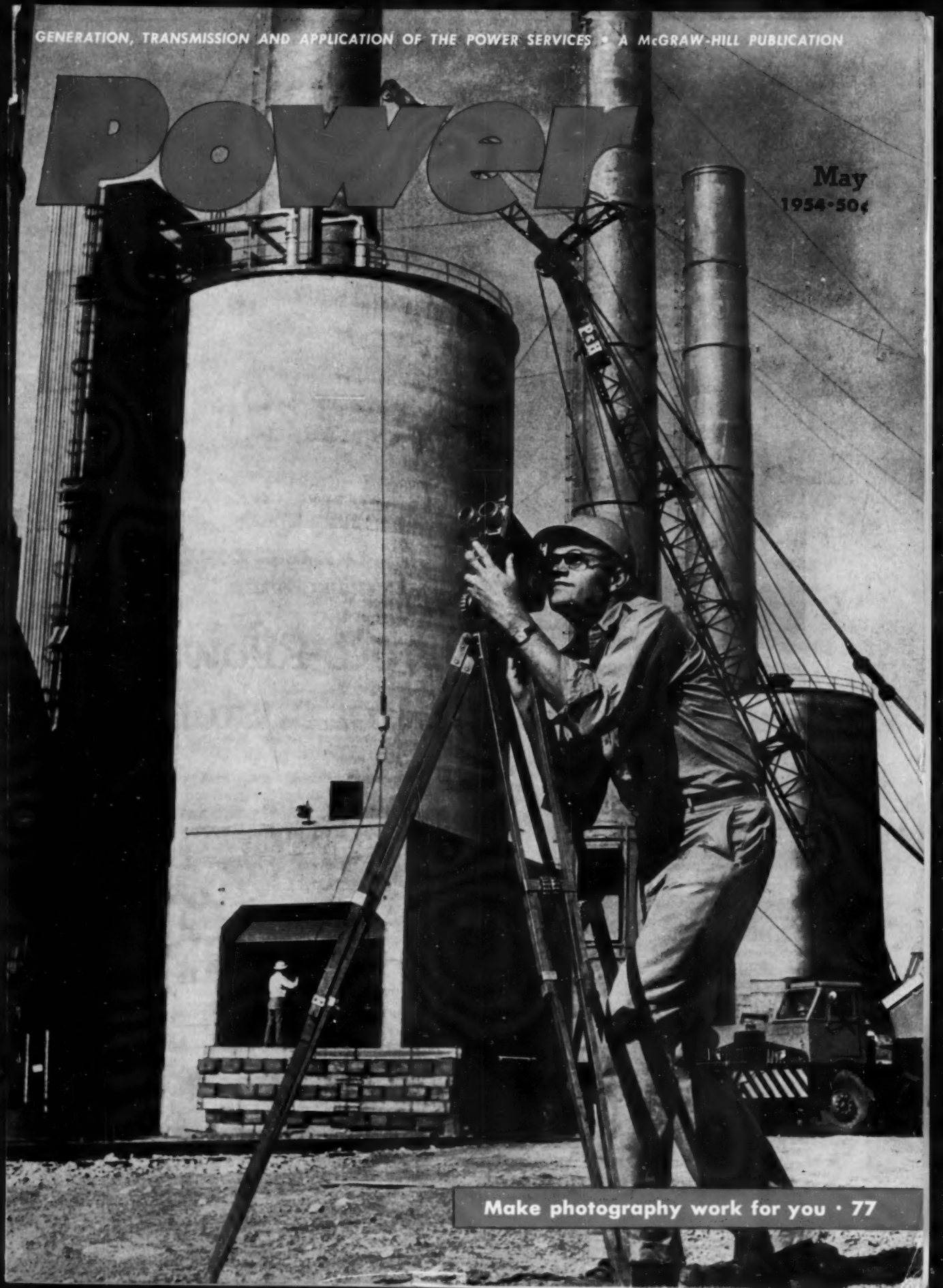
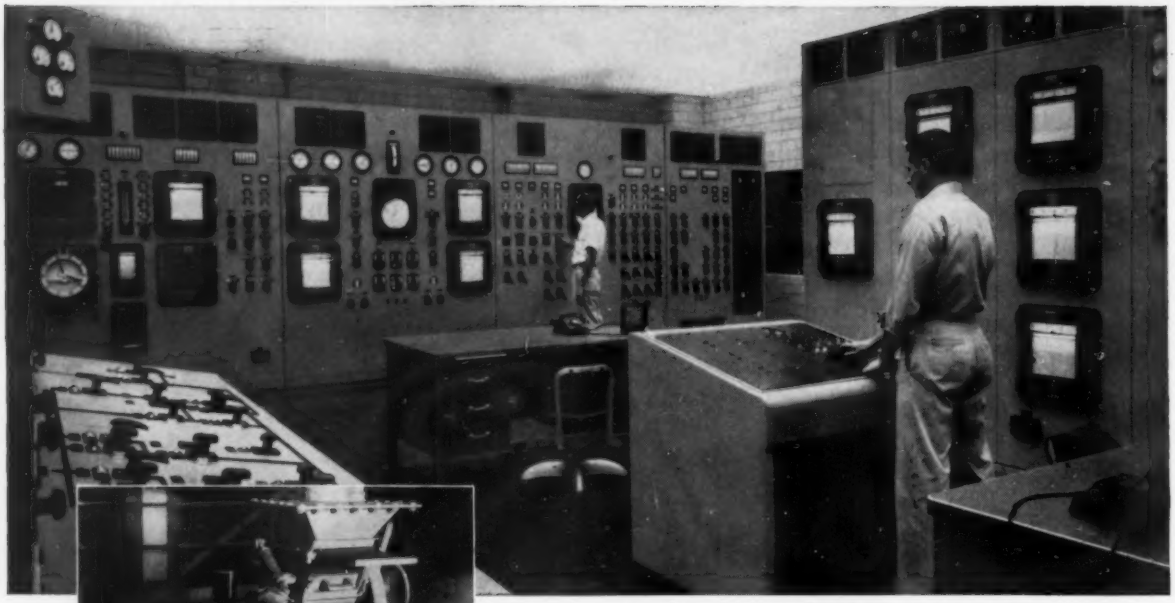
Power

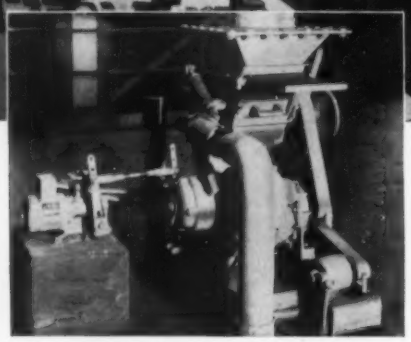
May
1954 • 50¢



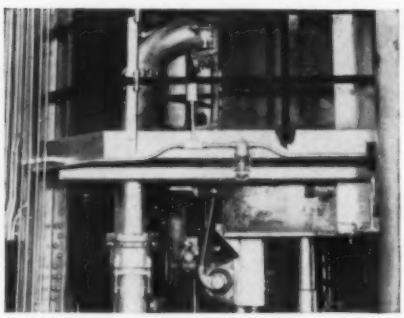
Make photography work for you · 77



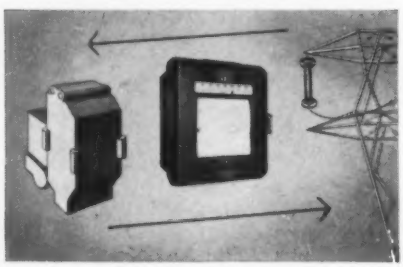
Load-frequency control & panel engineering



Combustion control



Superheat-reheat control



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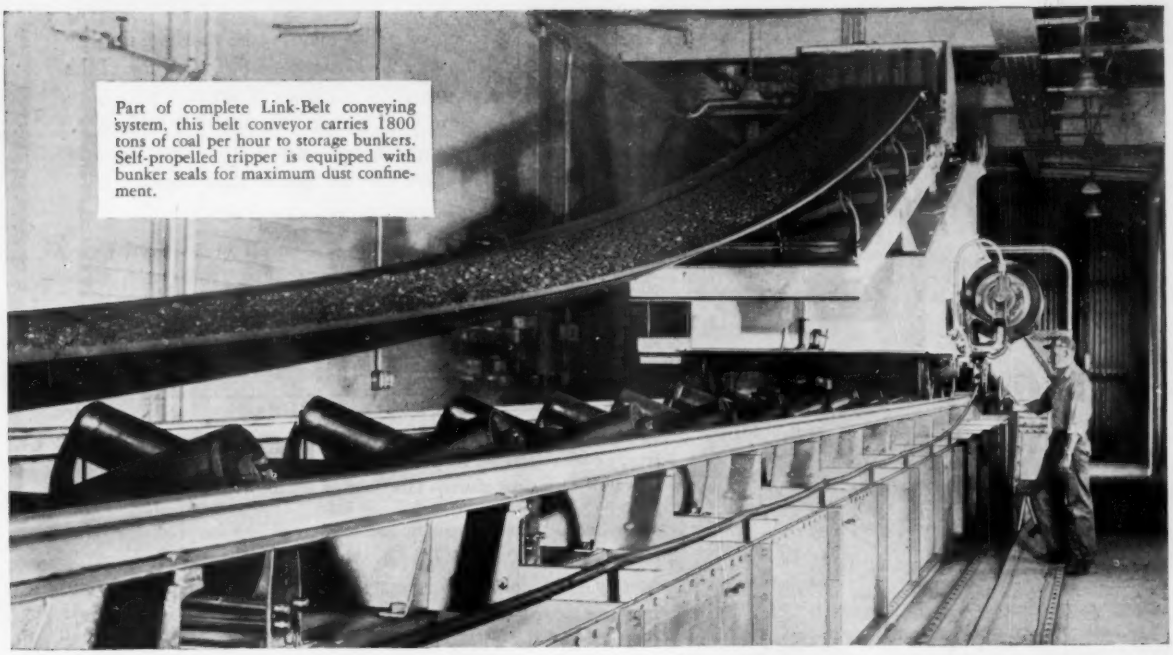

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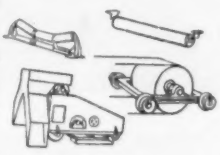

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13,488-B

Sure, that old pump still works,

but how much does it cost to keep?

That rugged old pump of yours may not be the bargain that it seems. Let's do some arithmetic. If the efficiency of the old pump is 75% vs. the 85% efficiency of the new pump, you are paying more to keep it than you would to replace it. That's because a new unit of equivalent output uses less power. Thus it soon saves its own cost — then begins to pay dividends.

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Old pump efficiency 63% . . . . . 99.5 BHP
New pump efficiency 69% . . . . . 91.0 BHP
8.5 BHP Saving

On the basis of 1¢ per KWH, the 8.5 BHP saving for 8,760 hours (a year of continuous operation) amounts to $560. This saving, capitalized in 10 years at 4%, adds up to $6,700. Yet the price of the new pump that saves $6,700 is only $1,101.

What would the pump replacement profit be in your particular case? Your De Laval representative can tell you exactly — in dollars and cents — as soon as he has the basic facts on your present installation. Call him in today or write to De Laval for Pump Fax Bulletin which includes a valuable "power-savings" chart.

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Power

MAY 1954 • VOLUME 98 NUMBER 5

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POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index.

PHOTOGRAPHY is stepping up fast on the ladder of industrial importance. Color, stereo and high-speed photographic developments are finding their way into industry. POWER has been on the lookout for a prime example—an organization making good use of today's photographic techniques—and has found it in Detroit Edison Company.

This month's cover points up one facet of the how-we-do-it picture—the construction phase. As brought out in our lead article, starting on p 77, shooting photos during overhaul of important machinery is a well-worked procedure in many plants today. But Detroit Edison goes several steps farther: standardizes maintenance procedures, even puts 3-D color and high-speed photos to work trouble-shooting.

The high-speed photo opens up a host of plant possibilities that fit in anywhere—from *seeing* water hammer to tracking down the why of a balky circuit breaker.

Next month

■ Heat Exchangers, a 32-p special report, is now in the final preparation-stages. Editors Ben Skrotzki and Tod Waldron have joined forces on this one. And from the early sketches and text we've seen, it promises to be another topnotcher.

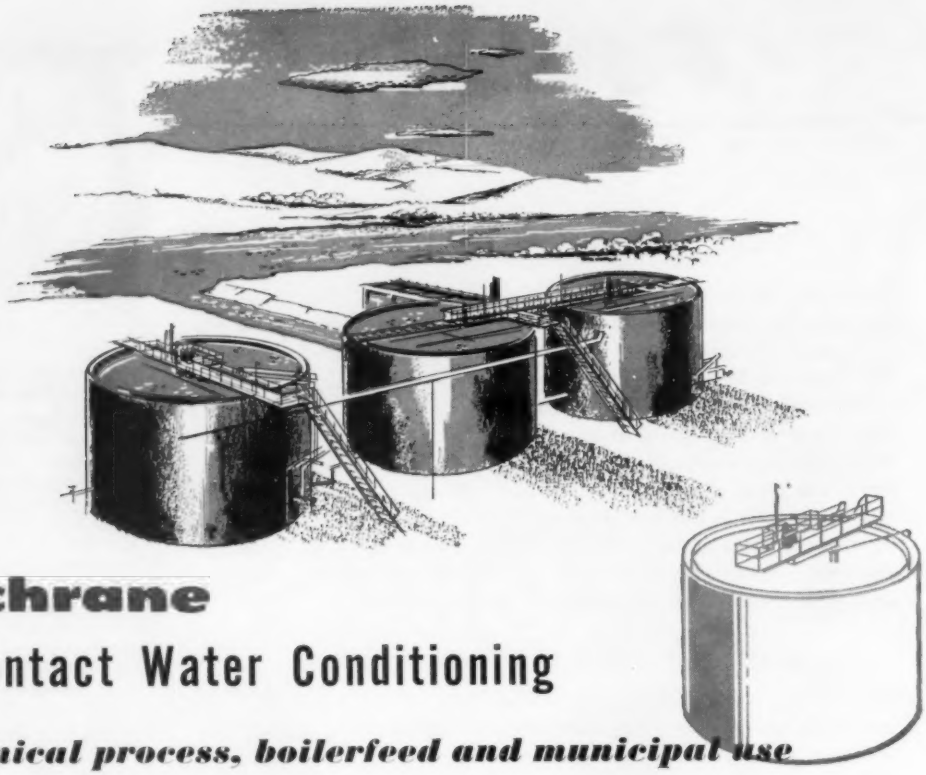
The report's first six pages wrap up the theory of heat transfer in easy-to-grasp fashion. Then follow the latest data on heat-exchanger types.

■ Space saving is dollar saving in any plant. And as outlined in a June article, a mezzanine installation of four air compressors not alone saved space but also served as a flood-damage preventive.

■ Iodine titration to measure excess sulfite in feedwater interests all power-plant operators. You'll want to read about a new additive to make the end-point of this titration easily recognizable.

You still have time!

■ POWER Awards for Modernization entries are being received to May 15th. Plants of any type, of any size, in any service, where a modernization program was completed during the calendar year 1952 or 1953, are eligible. For details see April issue, pp 94, 95. Drop us a note now asking for an entry blank.



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...with Power readers...

DOCTORS AND HOSPITAL PLANTS

About your editorial (POWER, March 1954, p 65, "Hospital Plants Need a Doctor"), we are fortunate, at our hospital, to have in our management, Board of Directors, and also in our Medical Board, the "doctor" you refer to. I feel . . . in most cases the inadequate equipment for services in hospitals has been caused mostly by the tremendous increase of beds needed in the past few years. The public should be aroused to the fact that contributions for hospitals should be made in the form of bequests not only for beds and rooms, but also for plant facilities and other pertinent services, such as laundry, kitchens, central supply and operating rooms.

I am of the opinion that the power plant and other service departments, regardless of their condition, should be open to the public for inspection. A visit to the forgotten department of hospital service is often a form of relaxation both for the person in the waiting room as well as for the convalescent patient. Invariably they will say, "Whoever realized how much is required, and how important the power plant and its auxiliaries are to the well-being of the sick."

ALFRED J MILLER, *Chief Engineer*
New Rochelle Hospital

...lines and bylines

F G Feeley, Jr

OUTDOOR PLANTS are close to the heart of F G Feeley, Jr, as you'll gather after reading his article, p 90. Frank did two years at MIT before the big depression hit. But the study side of power engineering did not end there. Stevens Institute plus extension courses elsewhere rounded out Feeley's school background.

To start on the road toward his present position as mechanical engineer with Carbide and Carbon Chemicals Co, Frank entered a ship's engine room, applied himself, and shortly cornered a 2nd Assistant Engineer's license in steam. Then after a spell with B&W's service dept—during which he placed in service some of the "big ones," including the Williamsburg plant of BMT and Niagara-Hudson's Oswego Station—the Navy tapped him. Frank joined C&C after about four years in the service.

After hours, Frank can be seen on a 32-ft auxiliary ketch in Long Island Sound, weather permitting. And like most true boatsmen, spells on the water are sandwiched between boat working sessions.

Pat Schlesinger

TOP WORKING DIESELS and Pat Schlesinger are synonomous to many. Pat's article, p 102, starts, "Our newest engine is a 4275-hp Nordberg gas-burning diesel." And if you know Pat you can just feel his enthusiasm building up. Pegged as an outstanding diesel-plant operating man, and rightly so, we feel, Pat on many occasions has trotted out to advantage his smart, practical approach to knotty diesel problems. He is interested in the Oil and Gas Power Division of ASME.

Ponca City diesel plant may rightly be classed as Pat's pet project. Visitors could hardly drop in without seeing Pat in or around the plant. And you'll find him with his hat on, ready for a fast move, if and when he's needed. Hunting and trapping big game are activities that fill out Pat's off hours.

W B Warner

BEARING LINEUP by telescopic sighting is the current concern of Bill Warner, as you can tell from his article on pp 113-117. He is superintendent of the Station Construction Shops Dept with Consolidated Edison Co in N. Y., having gone with the company in 1946.

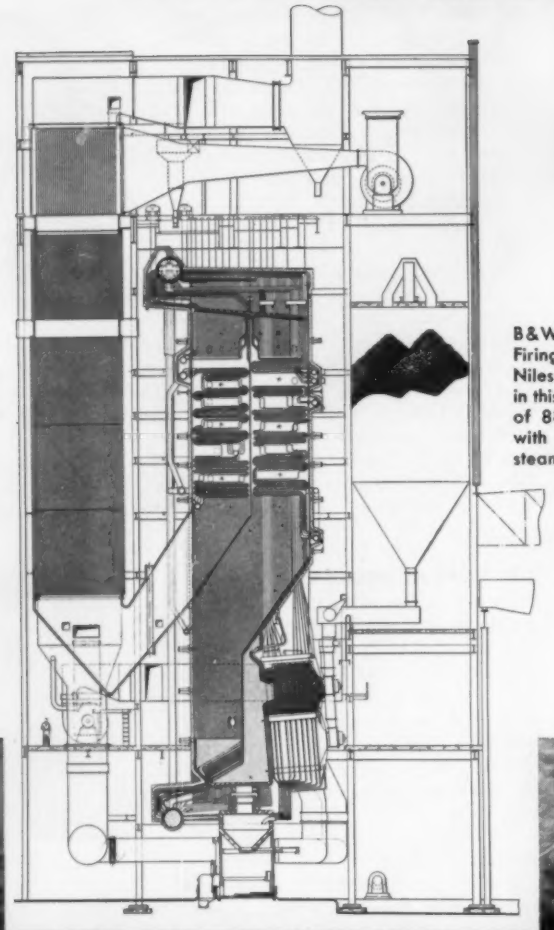
From Axe, Mich., Bill moved to N. Y. and graduated from Stevens Institute. After several years with Westinghouse Electric Corp as service engineer, he joined Con Edison in N. Y.

Bill's hobby is a neat switch on his professional work. By days, he concerns himself with overhauling and aligning turbine-generators. At night, he can generally be found in his basement workshop, designing and building model airplanes. He's an amateur pianist to boot.

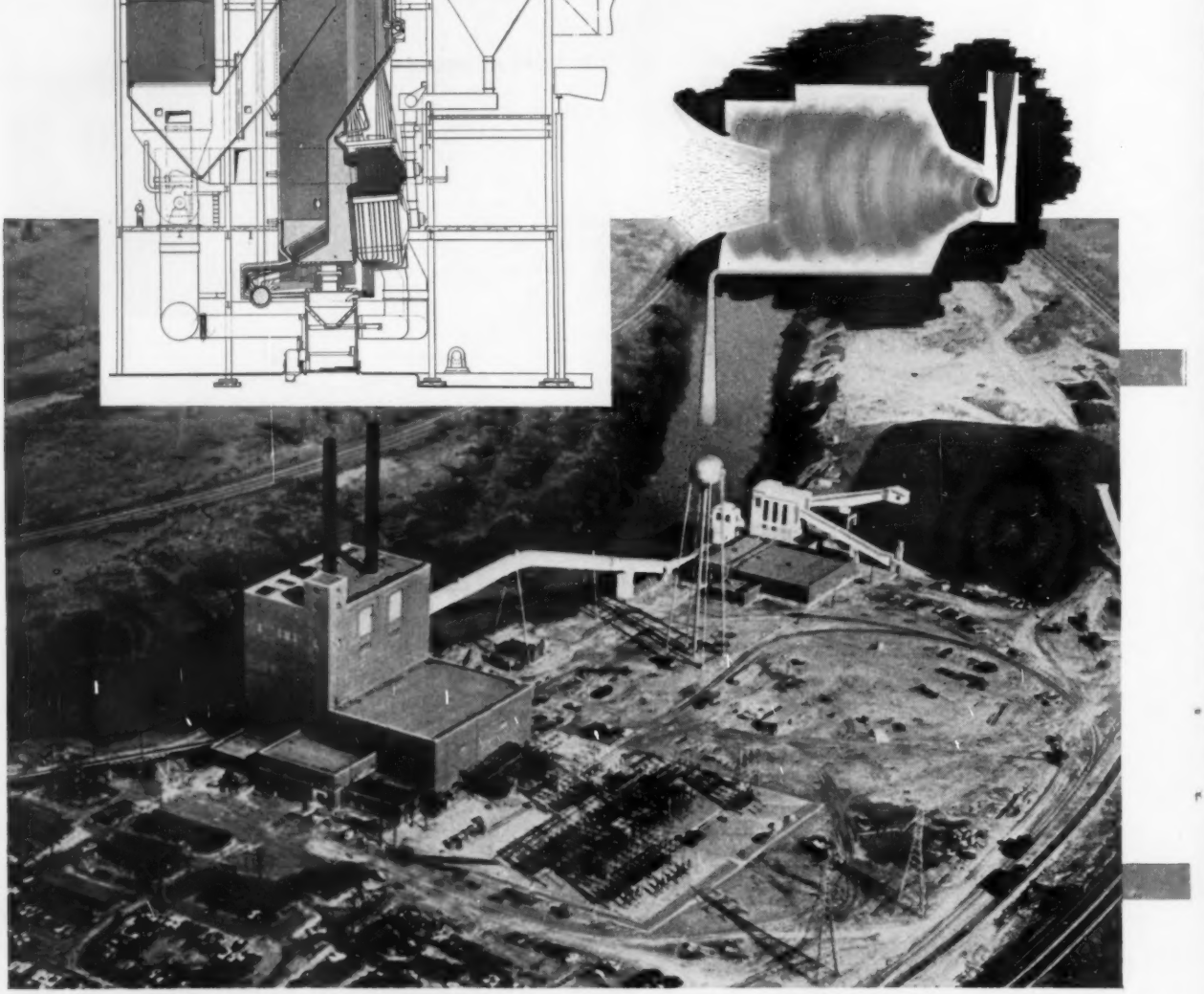
Working alongside Warner is R H Brenner, superintendent's asst. After receiving a CE degree from Manhattan College in 1926, Brenner went with N. Y. Steam Co and later Con Edison. Right now, he wrestles with building maintenance problems. His 25-acre farm in Jersey, plus night teaching, takes his spare time, and then some.

New **B&W** *Pressurized,*

on the line at



B&W Radiant Boiler with Cyclone Furnaces, Pressure-Firing, Cyclone Steam Separators and Reheat for the Niles Station of Ohio Edison Co. Each of the two units in this station has a maximum continuous steam capacity of 885,000 lb per hr. Design pressure is 1650 psi, with pressure at superheater outlet 1485 psi. Final steam temperature is 1000 F with reheat to 1000 F.



Cyclone Furnace Boiler

NILES STATION

Reflecting the need for additional power facilities in the area it serves, Niles Station is a tribute to the foresight of executives of Ohio Edison Company and its consulting engineers, Commonwealth Associates, Inc. Built into this new station are many technical advances to achieve economical construction costs while assuring efficient long-range power generation. For example, the two B&W Boilers for Niles Station, the first of which is now on the line, incorporate such engineering features as:

- Cyclone Furnaces for efficient use of low grade coals, with provision for burning oil or gas when conditions warrant.
- Pressure-Firing, with elimination of induced draft fans.
- Cyclone Steam-Separators for natural circulation and high-purity steam to the turbine.
- High superheated and reheated steam temperatures.

Elimination of Heavy Fly-Ash Discharge with Cyclone Furnaces

Cyclone Furnace Boilers offer many advantages. One important feature is the elimination of heavy fly-ash discharge from the stack. Most of the ash from the burning coal is melted into easy-to-handle slag right in the Cyclone Furnace. This ash never gets into the gas stream, with the result that dust loading to the stack is reduced to very small amounts . . . *often less than that specified by dust loading codes.* The Cyclone Furnace offers many other benefits. Through simplification of the entire process of coal preparation, combustion, ash segregation, and ash handling, it makes possible economies in initial cost, operating labor and fuel consumption. Maintenance costs are cut because so much maintenance-causing machinery is eliminated.

Higher Efficiency, Less Maintenance Through Pressure-Firing

Lower fuel consumption, easier operation, and less maintenance are made possible by pressure-firing and the elimination of induced draft fans. There is also a savings in auxiliary power consumption since the forced draft fan alone requires less power than that needed for a combination of forced and induced draft.

Positive Circulation, Clean Steam with Cyclone Separators

Adequate circulation of water throughout the unit is assured with safety by B&W's efficient Cyclone Steam Separators. Located inside the drum, these simple, stationary devices require no power, need no maintenance, do not take up building room. In conjunction with Steam Scrubbers, the Cyclone Separators make it possible to send steam of highest purity to the turbine, contributing to greater turbine efficiency and decreasing the amount of turbine cleaning required.

* * * * * * * * * * *

These and many other modern advances in combustion and high-pressure, high-temperature steam generation are available to you. We will be glad to discuss them with you in connection with your future plans. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

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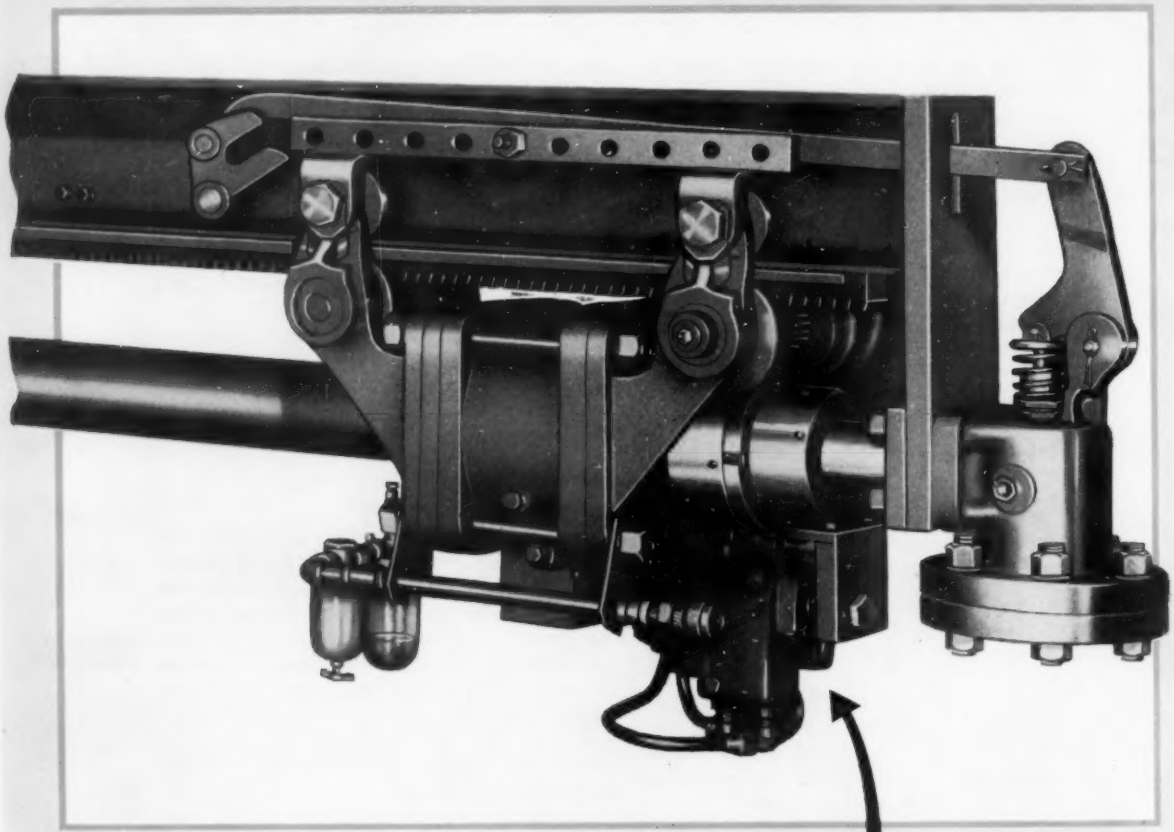
BOILER DIVISION

G-629

Single Motor Drive



A single motor (air or electric) both rotates and propels the long lance tube

4790

Another important advantage of

DIAMOND Model IK Long Retracting Blowers

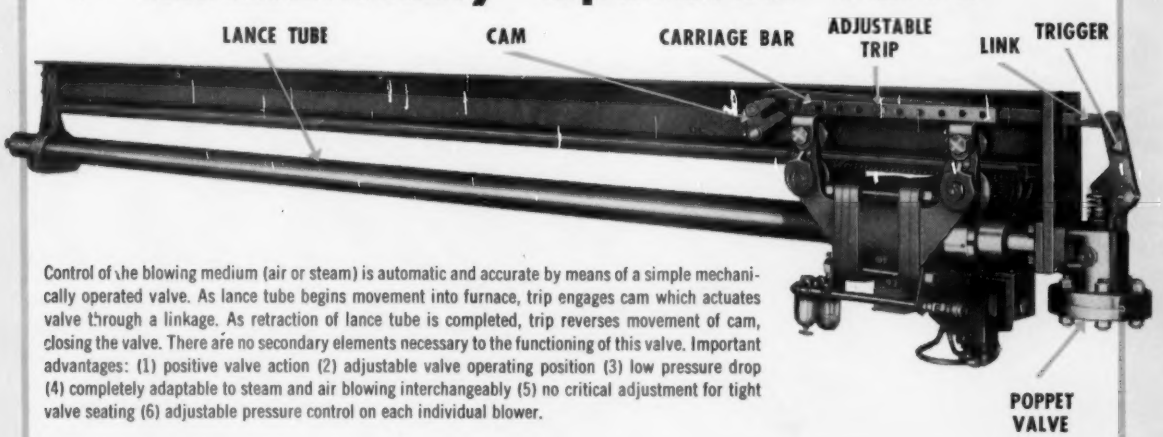
A single motor, simultaneously propelling the carriage and rotating the lance tube, through a rugged system of gears, represents the ultimate in simplicity and reliability. There is only one set of motor elements, one set of control elements, and one set of power supply facilities to operate and to maintain. This feature of the Model IK Blower is an excellent example of the Diamond policy of simplification that means more dependable operation and lower maintenance costs. Another feature of the Model IK that has the enthusiastic approval of users is the mechanically operated valve (see below). Opening and closing of the valve is positive, dependable and accurate . . . all essential to correct performance. Here again note the simplicity of the mechanism. For further information, ask for a copy of Bulletin 1080U.

DIAMOND POWER SPECIALTY CORP.

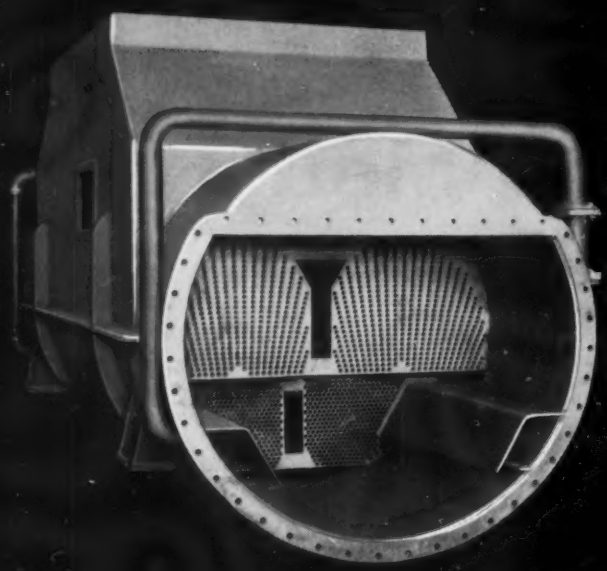
LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

Mechanically Operated Valve

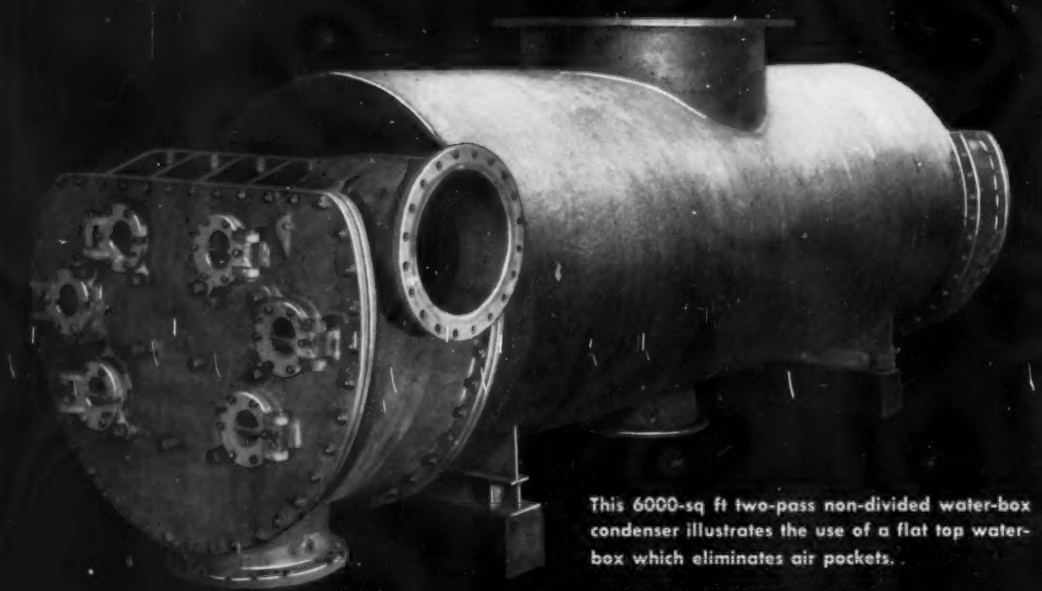


Control of the blowing medium (air or steam) is automatic and accurate by means of a simple mechanically operated valve. As lance tube begins movement into furnace, trip engages cam which actuates valve through a linkage. As retraction of lance tube is completed, trip reverses movement of cam, closing the valve. There are no secondary elements necessary to the functioning of this valve. Important advantages: (1) positive valve action (2) adjustable valve operating position (3) low pressure drop (4) completely adaptable to steam and air blowing interchangeably (5) no critical adjustment for tight valve seating (6) adjustable pressure control on each individual blower.

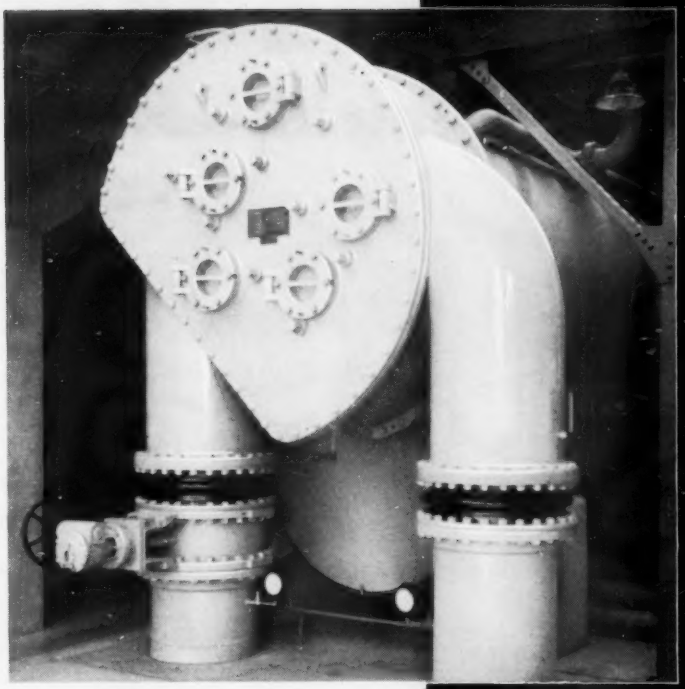


A 10,000-sq ft divided waterbox condenser with tube plate removed, showing the fan type tube layout, air offtake baffles, and staggered arrangement of tube supports. This tube support design aids uniformity in steam distribution by permitting free circulation throughout the unit, instead of creating separate cells which would result in excessive pressure drop or dead spaces in the ends of the condenser.

ELLIOTT condenser



This 6000-sq ft two-pass non-divided water-box condenser illustrates the use of a flat top water-box which eliminates air pockets.



An outdoor installation of an Elliott 11,000-sq ft surface condenser with side steam inlet and storage hotwell. The condenser is connected to the turbine exhaust by means of an L-shaped connection.

engineering assures—

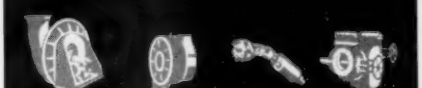
1. Maximum penetration of steam, with minimum pressure drop, due to improved tube layout.
2. Condensate temperature equal to steam temperature.
3. Minimum oxygen content of condensate.
4. Minimum terminal difference — the temperature difference between steam in the top of the condenser, and the discharge water.
5. All these factors carefully retained regardless of condenser size, in a unit adopted in every respect for the service required, and designed to fit available space.

• TUBE LAYOUT AND TUBE SUPPORT have been the subject of continuous study by Elliott engineers, resulting in definite advantages. The fan type arrangement of tubes in Elliott Type F condensers promotes maximum steam penetration, and regulates steam velocity so as to keep tubes swept free of condensation and non-condensibles; the strategic location of air offtakes also prevents dead spaces. Tube supports are not continuous, but upper and lower sections are staggered, avoiding the dividing of the chamber into individual cells. Type F condensers are built in sizes from 500 to 15,000 sq ft, in both divided and non-divided water box types. For details consult your local Elliott engineer, or write Elliott Company, Condenser Dept., Jeannette, Pa.

ELLIOTT Company

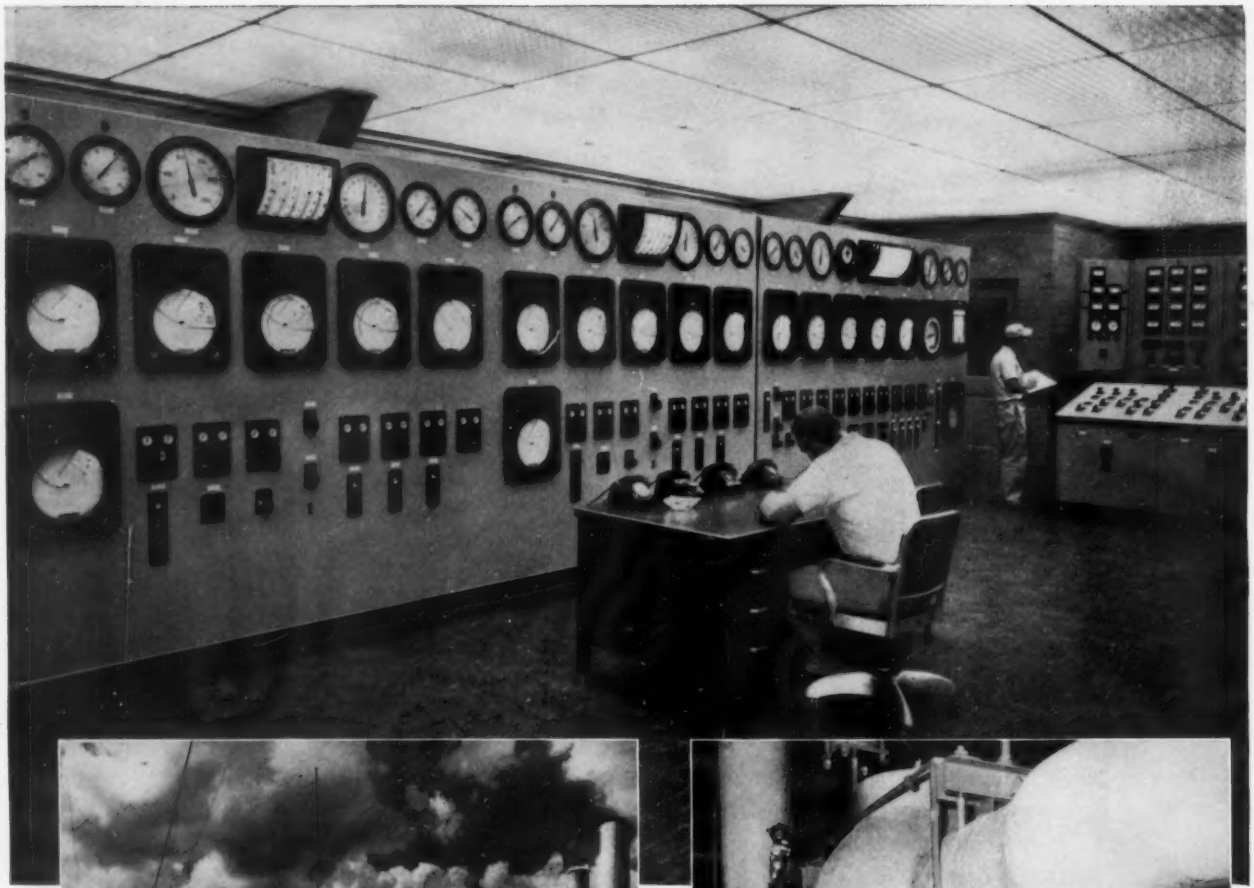
C4-1

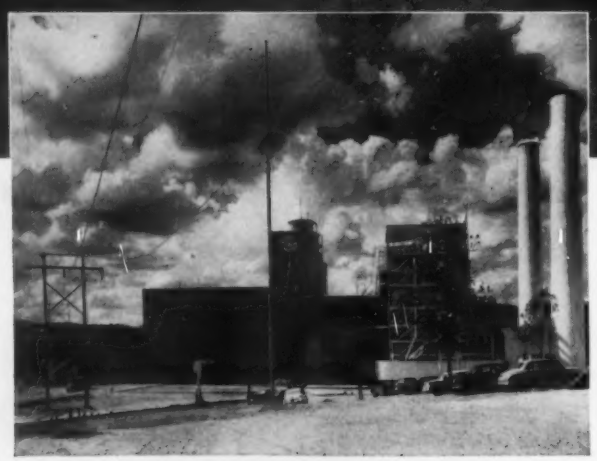
TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS

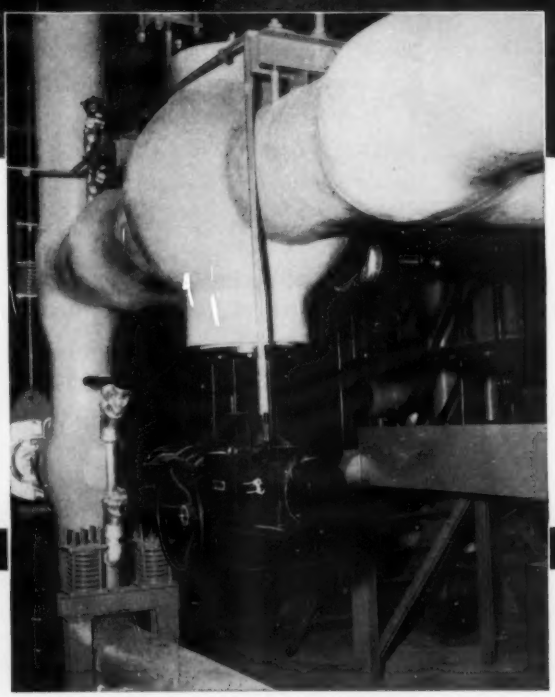


COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

Here's the *1,153rd*







**At Lake Catherine Station,
Arkansas Power and Light Company**

***Above*—Centralized control room for Bailey Controls of Feed Water, Combustion and Steam Temperature.**

***Right*—Bailey Three-element Feed Water Control Valve.**

Installation of . . .

Bailey Three-element Feed Water Control

★ This installation of three-element feed water control at the Lake Catherine Station of Arkansas Power and Light Company is not the latest, the largest, or the most unusual; but it is important to you as a user of power generating equipment.

Here's why: It is a part of the widespread and well founded acceptance of Bailey Three-element Feed Water Control Systems. No other manufacturer can offer you an equal background of experience in this advanced method of feed water control.

Contributing to this overwhelming endorsement are several factors: Not only has the basic principle been proved and re-proved in use, but the design of the equipment has been similarly stabilized and improved. As a result, Bailey has established a reputation for successful operation in difficult installations where other systems have failed. And a twenty-five year backlog of experience has contributed unusual records for accuracy and dependability in operation.

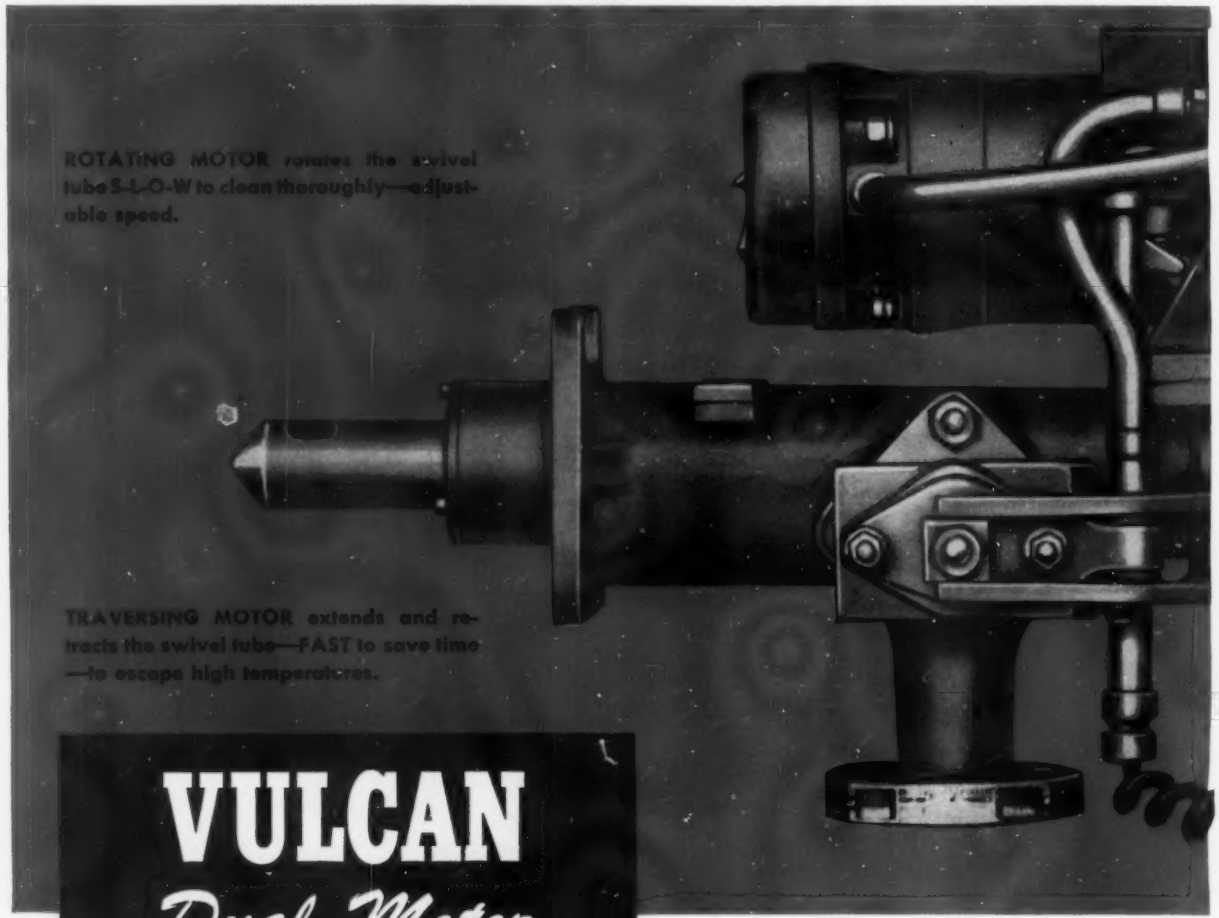
Even more important, the Bailey field engineering service, established in important industrial centers, insures prompt and efficient service and installation supervision regardless of your location. Your local Bailey office will be glad to arrange an inspection trip to a near-by installation of Bailey Three-element Feed Water Control. Give them a call today. And for catalog literature, including a partial list of installations, write for Bulletin No. 105-C.

A-122-2

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

How to STOP


ROTATING MOTOR rotates the swivel tube S-L-O-W to clean thoroughly—adjustable speed.
TRAVERSING MOTOR extends and retracts the swivel tube—FAST to save time—to escape high temperatures.

VULCAN
Dual-Motor Wall Deslaggers

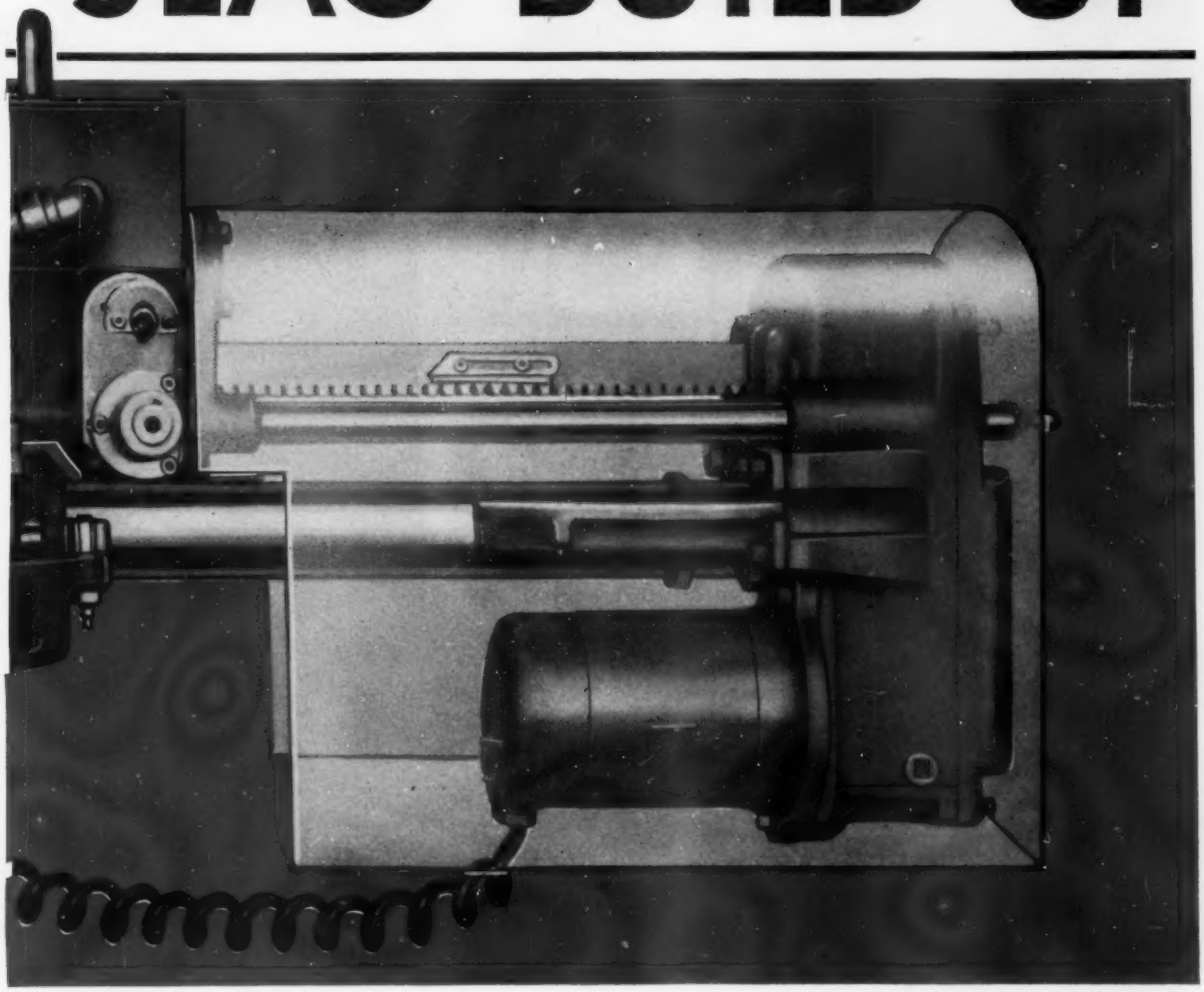
With direct-acting valve Clean BETTER and FASTER

KEEP slag and sintered dust from upsetting heat-transfer capacity and superheat or reheat control. Stop their build-up—quickly and effectively—with the high-power mass blowing and fast action of Vulcan Wall Deslaggers.

Thanks to dual-motor drive—electric or air, electric shown—a Vulcan Deslagger

VULCAN *Automatic*

SLAG BUILD-UP



extends into the boiler, cleans and retracts from the high-temperature zone—all in 76 seconds. The cycle can be repeated often, if needed to control deposits.

Steam, air or water—or any combination of them—may be used as the blowing medium without change in equipment. The blowing or cleaning arc can be any angle up to a full 360 degrees.

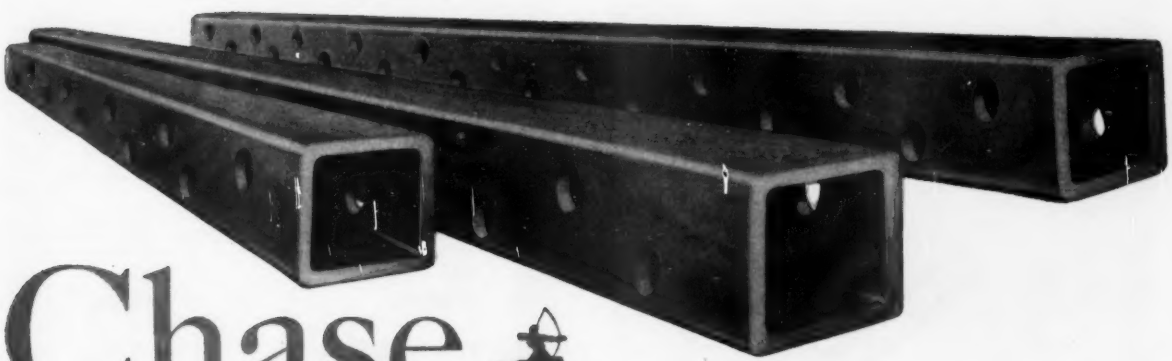
The story is told in detail by new Bulletin 1016. Write for it.

COPES-VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ERIE 4, PENNSYLVANIA

BETTER...

because it's ventilated

The cross section configuration of Chase Ventilated Square Copper Tube Bus Conductor makes it much stronger mechanically to withstand heavy short circuit stresses... allows longer unsupported lengths. And those vent holes with their heat dissipating properties increase the current-carrying capacity of Chase Bus Conductor up to 20%, resulting in a saving of up to 36% in weight of copper. In every way, Chase Ventilated Square Copper Tube Bus Conductor is *better*. Call your nearest Chase warehouse and sales office for full information.



Chase®

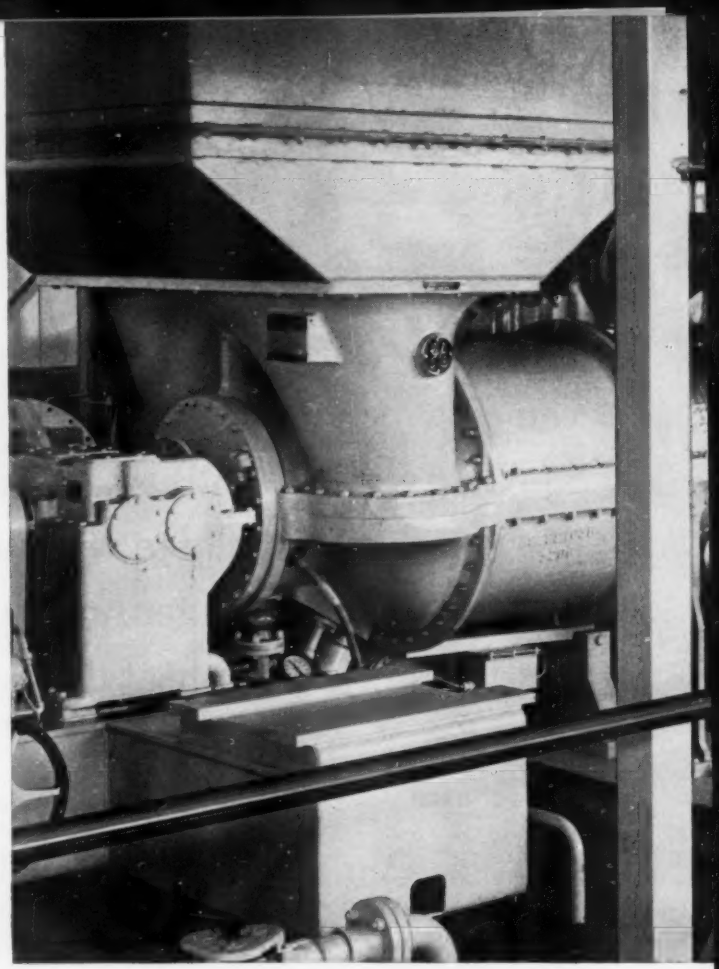
BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

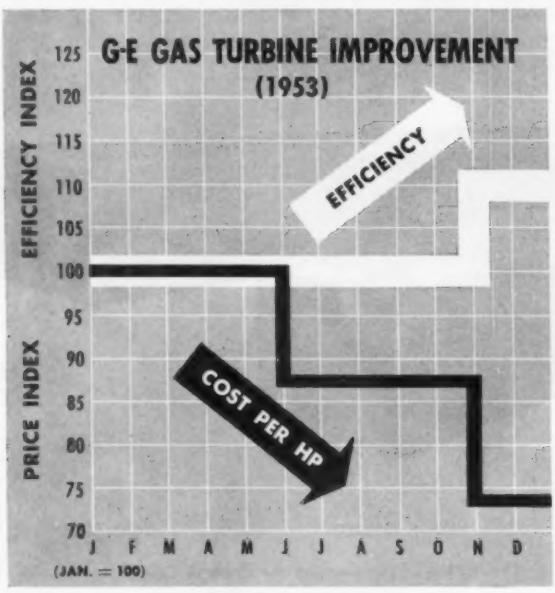
Albany†	Chicago	Denver†	Kansas City, Mo.	Newark	Pittsburgh	San Francisco
Atlanta	Cincinnati	Detroit	Los Angeles	New Orleans	Providence	Seattle
Baltimore	Cleveland	Houston	Milwaukee	New York	Rochester†	Waterbury
Boston	Dallas	Indianapolis	Minneapolis	Philadelphia	St. Louis	(†sales office only)

GAS TURBINE
progress report



In the past year, G-E engineers have reduced the cost per hp of the G-E gas turbine—and boosted its efficiency an average of 11 per cent. You may be able to put this versatile prime mover to work providing low-cost power for your plant.

Increased Efficiency, Versatility,

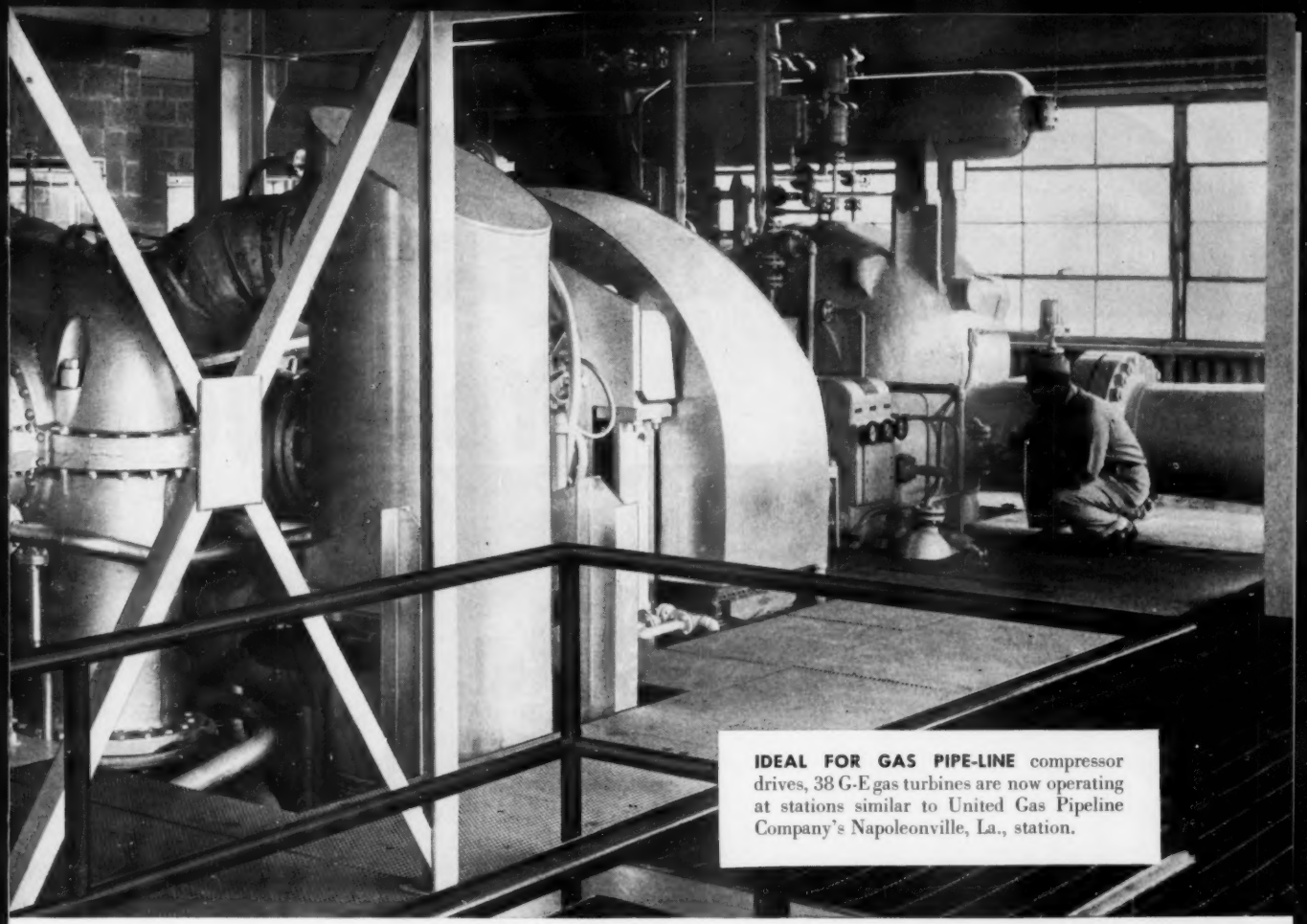


GREATER EFFICIENCY AND LOWER COST PER HP, achieved by improved design and manufacturing techniques, were significant G-E gas-turbine advances in 1953.

G-E GAS TURBINE OPERATING RECORD
(As of March 15, 1954)

TYPE OF SERVICE	NO. OF UNITS	OPERATING HOURS
LOCOMOTIVES	11	60,000
POWER GENERATION	16	70,000
GAS PIPE-LINE PUMPING	38	150,000
PETRO-CHEMICAL	1	3,000
TOTAL	66	283,000

UNEQUALED RECORD for operating hours and diversity of application, shows versatility and dependability of G-E gas turbine, gives G-E engineers vital data for future progress.



IDEAL FOR GAS PIPE-LINE compressor drives, 38 G-E gas turbines are now operating at stations similar to United Gas Pipeline Company's Napoleonville, La., station.

Lower Cost Per Horsepower Mark G-E Gas-turbine Progress

In less than five years, what was a completely new, un-tried prime mover has been shaped into a dependable, economical means of power. Already G-E turbines have racked up over 280,000 hours driving railroad locomotives, generating electric power, and turning high-speed compressors for gas pipe-line pumping and other industrial processes.

In the past year alone, G-E engineers have reduced the cost per horsepower for the gas turbines an average of 26 per cent. In the same short span, they have boosted efficiency an average of 11 per cent.

Outstanding among recent improvements is an integral base on which the turbine and its auxiliary equipment are permanently mounted and shipped—substantially reducing installation costs.

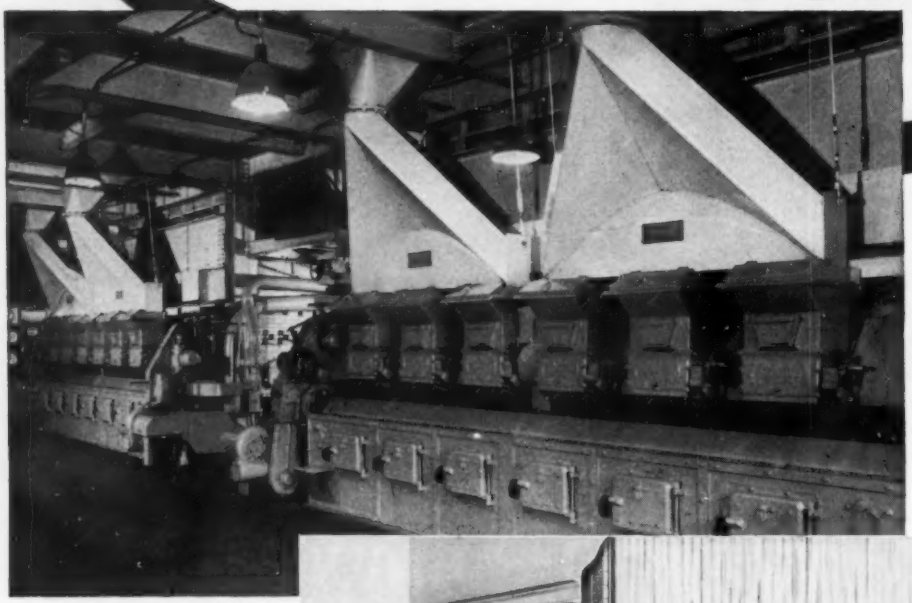
How could all this happen? General Electric, leader in the design and manufacture of both steam turbines and jet engines, was well equipped to develop the combustion gas turbine. Now, with thousands of hours of operating experience already accumulated, and with a factory designed exclusively for their manufacture, G.E. is leading the way in the gas turbine field.

If you would like more information on the gas turbine, contact your nearest G-E Apparatus Sales Office or write to General Electric Company, Section 255-10, Schenectady 5, New York.

You can put your confidence in—

GENERAL ELECTRIC

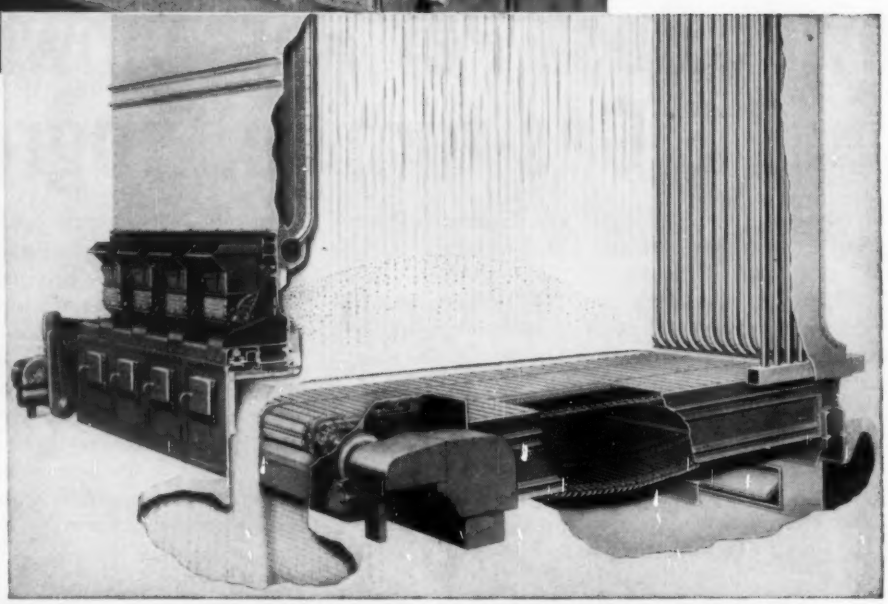
Detroit Rotograte Has You Need



Typical installation of Detroit RotoGrate Stokers in prominent Midwestern Plant. Units designed for capacities of 150,000 pounds of steam per hour each.

Cut-away view of a typical water cooled furnace of a steam generator. Two feeders are removed to show the specially designed overlapping grate that moves slowly forward to continuously discharge the ash at the front. A scientifically designed reinjection system provides effective furnace turbulence.

Detroit RotoGrate Stokers may be applied to all types and makes of boilers or steam generators, and are available for capacities up to 400,000 pounds of steam per hour per unit.



DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

Works at Monroe, Michigan • District Offices in Principal Cities

The Features in a Stoker:

- Burns any Bituminous coal or Lignite.
- Requires no special fuel preparation.
- Exceptional fuel economy.
- Low auxiliary power.
- Increased capacities due to higher burning rates.
- Responsive to fluctuating loads.
- Continuous ash discharge eliminates intermittent cleaning.
- Coal feed, air supply and ash discharge are automatically controlled.
- Air for combustion may be preheated.
- Availability high—Maintenance low.

Hundreds of such RotoGrate installations have been made since first introduced by us in 1938. Repeat order customers are best evidence of satisfactory performance.

Do you need more steam? If so, investigate and order your Detroit Stokers now. Whether you are an old or new customer, we are at your service. Write for catalog.

There is a type and size of Detroit Stoker for every Industrial or Commercial need.

DETROIT ROTOGRATE STOKER

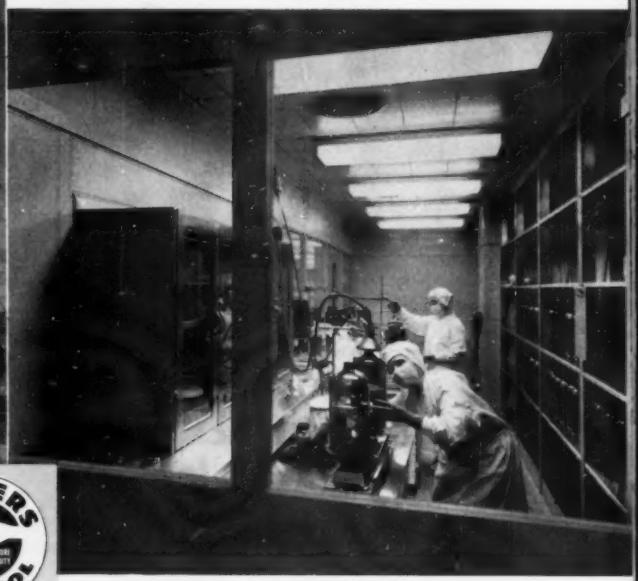
REPRESENTATIVE INDUSTRIAL ROTOGRATE USERS

- *Abitibi Power & Paper Co., Ltd.
- *Allied Chemical & Dye Corp.
- *Amalgamated Sugar Co.
- *American Crystal Sugar Co.
- American Cyanamid Co.
- American Distilling Co.
- American Steel Foundries
- Campbell Soup Co.
- Capitol City Products Co.
- Carborundum Co.
- *J. I. Case Co.
- Certain-teed Products Corp.
- Chesapeake & Ohio Railway Co.
- Chicago & Northwestern Railway Co.
- *Chrysler Corp.
- Clinton Industries, Inc.
- *Consolidated Paper Co.
- *Peter Cooper Corps.
- Crane Co.
- Crucible Steel Co. of America
- Cudahy Bros. Co.
- E. I. DuPont de Nemours & Co.
- Elliott Co., Inc.
- Falk Corp.
- *General Electric Co.
- *General Motors Corp.
- Goodyear Tire & Rubber Co., Inc.
- *Great Western Sugar Co.
- Hoberg Paper Mills, Inc.
- Illinois Central System
- Interlake Iron Corp.
- Jeffrey Mfg. Co.
- Jones & Laughlin Steel Corp.
- Kimberly-Clark Corp.
- *Libby-Owens Ford Glass Co.
- *Eli Lilly & Co.
- *Minnesota Mining & Mfg. Co.
- *Monsanto Chemical Co.
- *Nash-Kelvinator Corp.
- *New York Central System
- *Northwest Paper Co.
- Pabst Brewing Co.
- Pacific Mills
- *Pullman Standard Car Mfg. Co.
- Quaker Oats Co.
- Rochester & Pittsburgh Coal Co.
- *Rohm & Haas Co.
- Schmidt & Ault Paper Co.
- *Studebaker Corp.
- *Sutherland Paper Co.
- Tennessee Coal, Iron & Railroad Co
- *Tennessee Eastman Corp.
- United States Gypsum Co.
- United States Rubber Co.
- *Walworth Co., Inc.
- Western Electric Co., Inc.
- Wilson & Co., Inc.
- *Wyman-Gordon Co.

*Repeat Order Plants

ARMOUR'S NEW LABORATORIES *producing*

Left: **Parenteral Packaging Department.** One of the areas completely air conditioned.



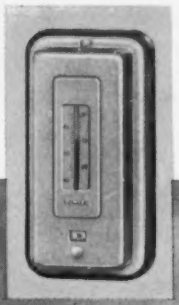
POWERS CONTROL

Above: **Hospital Gowned and Masked Technicians in Bulk Sterile Filling Area.** Here the air conditioning is treated in such a manner that aseptic operations could be undertaken with least possibility of bacterial contamination.

Below: **Low Temperature Human Blood Fractionation Plant** — *the largest in the U.S.A.* In this area there are processed 18,000 pints of human blood (or the equivalent of human plasma) weekly into Normal Serum Albumin and Poliomyelitis Immune Globulin. Processes are controlled by Powers V-Port FLOWRITE Valves. This entire room is accurately held at 23° F.

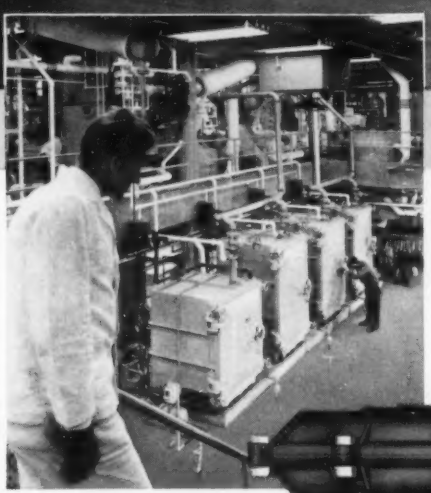
Above: **View in Parenteral Manufacturing Building No. 4** where ACTHAR, Insulin, and Intrinsic Factor (BIO-PAR) are processed. Processes here are also controlled by Powers V-Port FLOWRITE Valves.

Gamma Globulin and other pharmaceuticals...



Use POWERS AIR CONDITIONING CONTROL AND FLOWRITE DIAPHRAGM VALVES

New ARMOUR PHARMACEUTICAL CENTER, Near Kankakee, Ill.



Above: **View in Solvent Extraction Building No. 5** where Insulin, Intrinsic Factor and Injectable Liver are produced. Processes are controlled by Powers V-Port FLOWRITE Valves.

Architects & Engineers: HOLABIRD & ROOT & BURGEE
Piping Contractor: M. J. CORBOY CORP.

Gamma Globulin for Combating Polio, Serum Albumin used by the Armed Forces for transfusion in shock and burn cases, Thyroid powder and tablets, Intrinsic Factor (BIOPAR), Insulin and ACTHAR for treatment of arthritis – production of these and many other Armour products requires accurate temperature control.

To insure the precision control of air conditioned areas in their modern $12 million plant Armour installed a Powers pneumatic control system. To accurately control the flow of heating and cooling mediums and vacuum used for various processes, they installed Powers V-PORT FLOWRITE Valves.

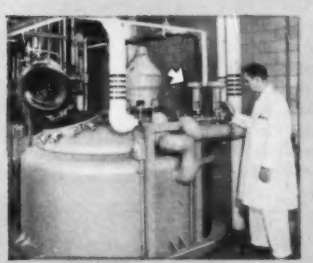
When you have a control problem requiring the dependable performance assured by Powers products – call our nearest office or write us direct.

THE POWERS REGULATOR CO.

SKOKIE, ILL. • Offices in Over 50 Cities in U.S.A., Canada and Mexico

Over 60 Years of Automatic Temperature and Humidity Control

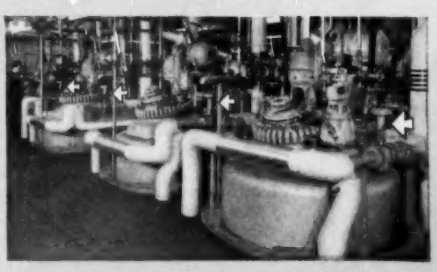
(b70)



Powers FLOWRITE Valve
Characterized V-PORT Type

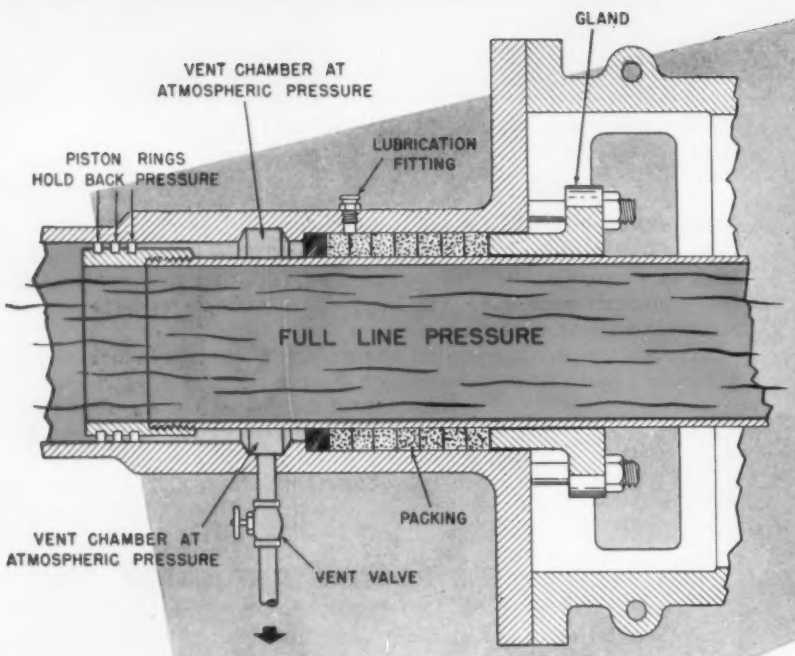
Gives BETTER Control with Less Maintenance

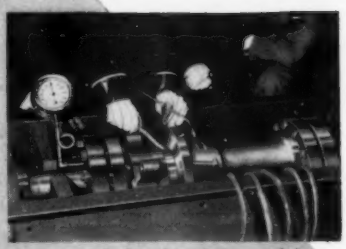
Over 100 are Used in Armour Laboratories.



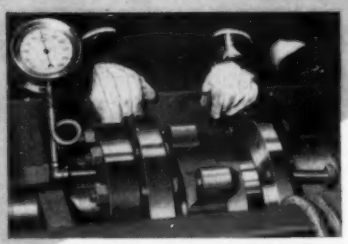
ACCURATELY CONTROLS STEAM, WATER, VACUUM AND PROPYLENE GLYCOL AT ARMOUR LABORATORIES

THE ONLY SLIP JOINT IN THE WORLD THAT CAN BE UNPACKED AND REPACKED AT FULL OPERATING PRESSURE





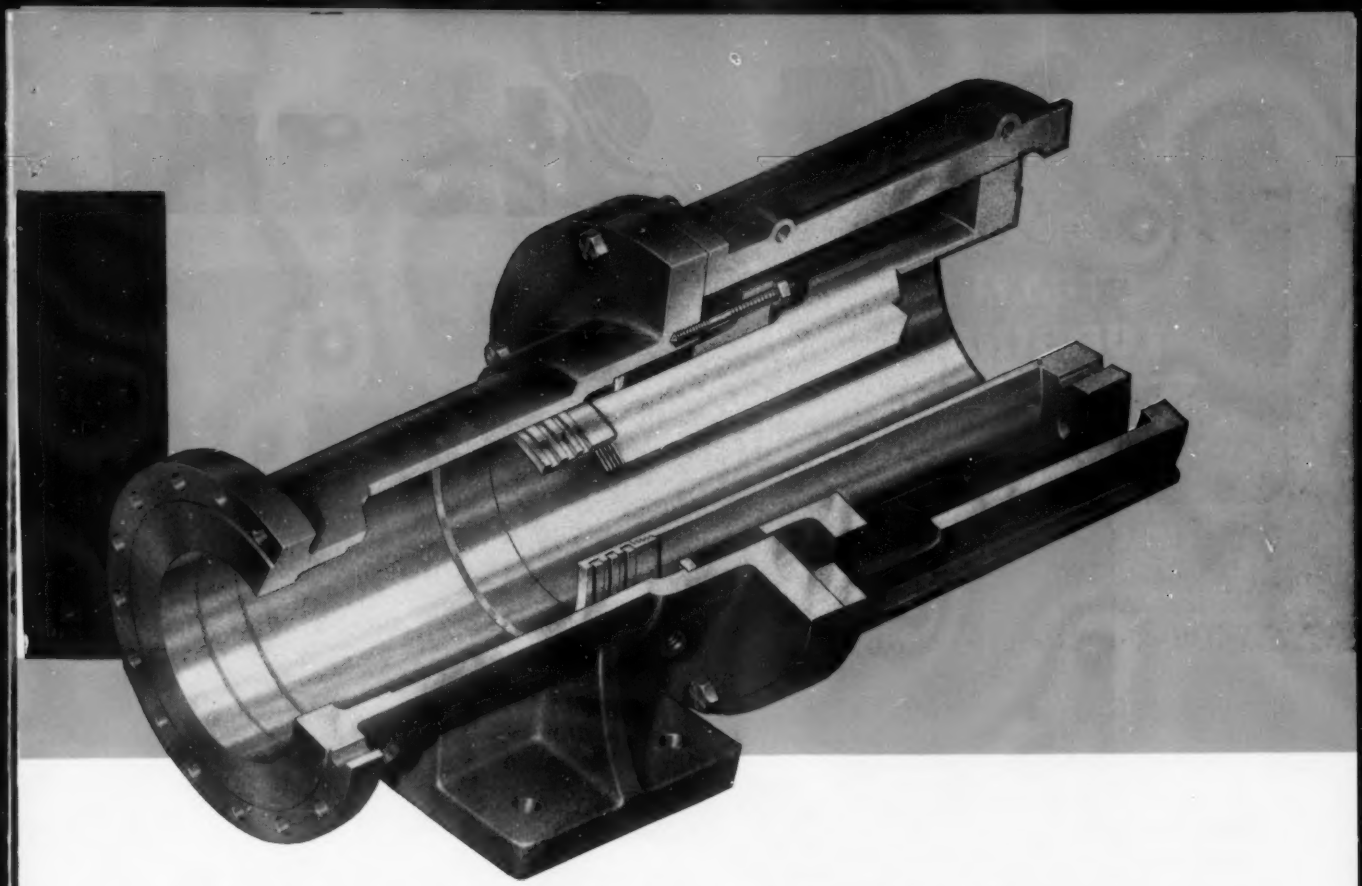
Last strand of packing being withdrawn from stuffing box.



All packing removed. No trace of steam in the empty stuffing box.

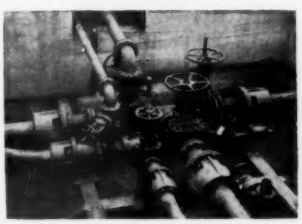
Unpacking and then repacking the stuffing box of an expansion joint under pressure not only is possible but also is easy and safe in an ADSCO Piston-Ring Joint. As can be seen in the drawing, full line pressure is maintained. The vent valve is opened to discharge, at a remote point, the small amount of fluid that passes the piston rings. This leaves the vent chamber at atmospheric pressure, thereby relieving the stuffing box area of all pressure.

With full pressure on the line side of the piston rings and atmospheric pressure on the stuffing box side, the difference in pressure seals the rings against the body. The gland then is pulled back, the old packing replaced with new, and the gland tightened up again ... Note the photographs. They were taken while steam in the line was at 240 lbs., with 300° superheat, yet no steam entered the stuffing box to hinder the packing operations.



For simple maintenance, a new ring of packing can be added to an ADSCO Piston-Ring Joint, but when the old packing has been allowed to become scored, it should be *removed* and the ADSCO Piston-Ring Joint is the *only* one in which this can be accomplished without shutting off line pressure. With the vent valve open, piston rings hold the line pressure while the joint is being serviced.

This fully-engineered joint has other outstanding features. To prevent misalignment, the slip is completely guided internally as it moves along the machined cylinder of the body and externally as it moves along the machined cylinder of the external guide. Thus, the slip is continuously guided at its extreme ends throughout its entire length of travel. Primary and secondary limit stops prevent the slip from being pulled out of the body. Openings in the external guide provide easy access to the packing gland for adjustment and the guide is built in halves to reduce the size of manholes required in underground construction.



ADSCO Expansion Joints installed in manhole

ADSCO Piston-Ring Expansion Joints are furnished in both single and double types, in a full range of sizes, with 4", 8", and 12" traverse per slip, for pressures to 400 psi and greater, and for temperatures to 800F and higher.

Write for Bulletin 35-15J

AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES
NORTH TONAWANDA, NEW YORK

PLANTS
NORTH TONAWANDA, N. Y., AND RICHMOND, CALIF.

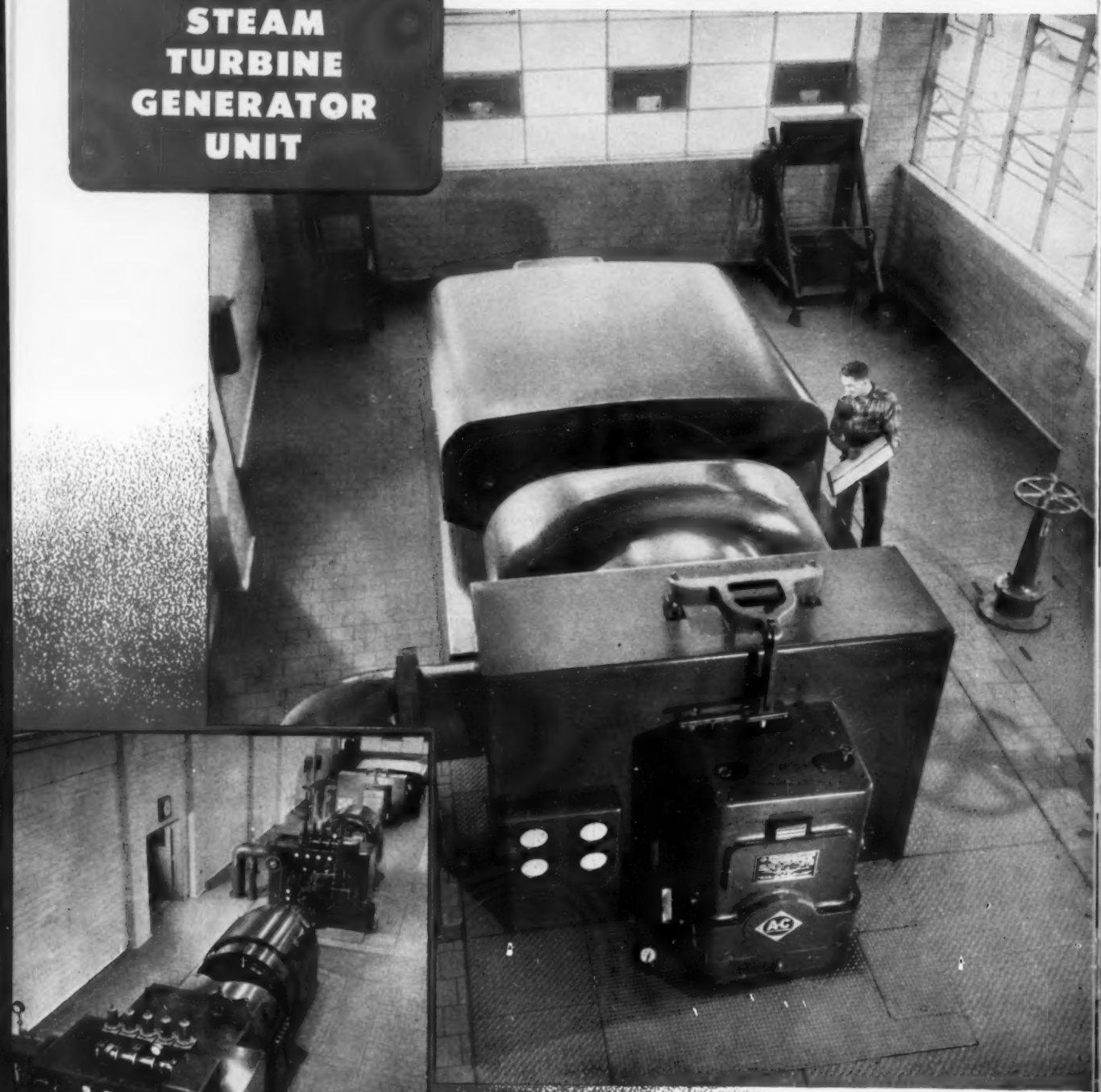
ADSCO ENGINEERED PRODUCTS

EXPANSION JOINTS • HEAT EXCHANGERS • STEAM TRAPS
STRAINERS • SEPARATORS • METERS

Steam

WA-Series

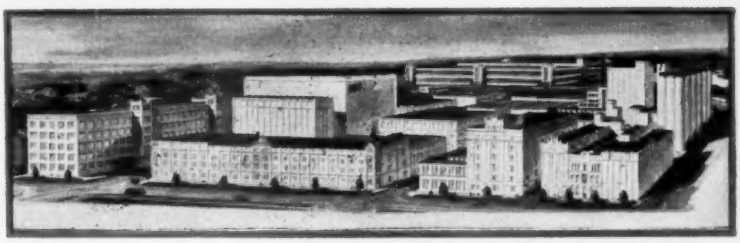
STEAM TURBINE GENERATOR UNIT



ALLIS-

Works Twice

FOR WORLD-FAMOUS BREWER



Jos. Schlitz
Brewing Company
Uses Steam for Both Processing
and Power Generation

Great quantities of steam are required for production of the "beer that made Milwaukee famous" at a rate exceeding six million barrels of beer a year. With so much steam needed for process, the electric power needed for plant operation is generated as a by-product.

At the Schlitz home plant in Milwaukee, two Allis-Chalmers 2500-kw, automatic extraction condensing turbine-generator units have been supplying process steam and electric power for the past five years. Recently, when more generating capacity was needed to match rapid plant expansion, Schlitz again turned to Allis-Chalmers.

Now operating 24 hours a day, 7 days a week, the new 5000-kw turbine-generator shown here was installed in the space originally planned for a third 2500-kw unit. It consists of a condensing, automatic extraction, impulse turbine and a housing type, air-cooled generator and exciter all carefully engineered and manufactured to operate as an integrated unit.

Built for condensing or non-condensing service in NEMA standard ratings 2000 kw and larger, the modern WA-Series unit is designed to meet modern power plant requirements. Bulletin 03B7654 gives complete details. For your copy, just call your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4269

WA-Series Features

For easy installation and maintenance, every detail of the unit is designed for maximum simplicity. Three-bearing construction; above-the-floor oil piping; bracket-bearing, housing-type air-cooled generator — all result in a compact unit that simplifies foundation requirements. Shipment of the turbine and the generator with their rotors in place further minimizes installation time.

Maximum reliability is assured by labyrinth spring-backed steam seals throughout, removable external glands, high chrome alloy steel buckets and nozzles, and time-proved governing system.

CHALMERS

A-C ALLIS-CHALMERS

STANDARDIZE!

ECONOMIZE!

with the bushing that's interchangeable

TAPER-LOCK

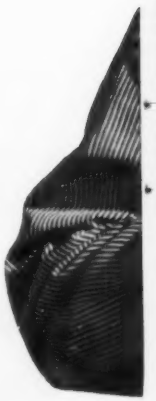
A PATENTED PRODUCT OF DODGE

Now mount 'em all—your sheaves, sprockets, couplings, conveyor pulleys—with Taper-Lock bushings. You'll save time, save money, and keep production rolling by standardizing on these interchangeable bushings.

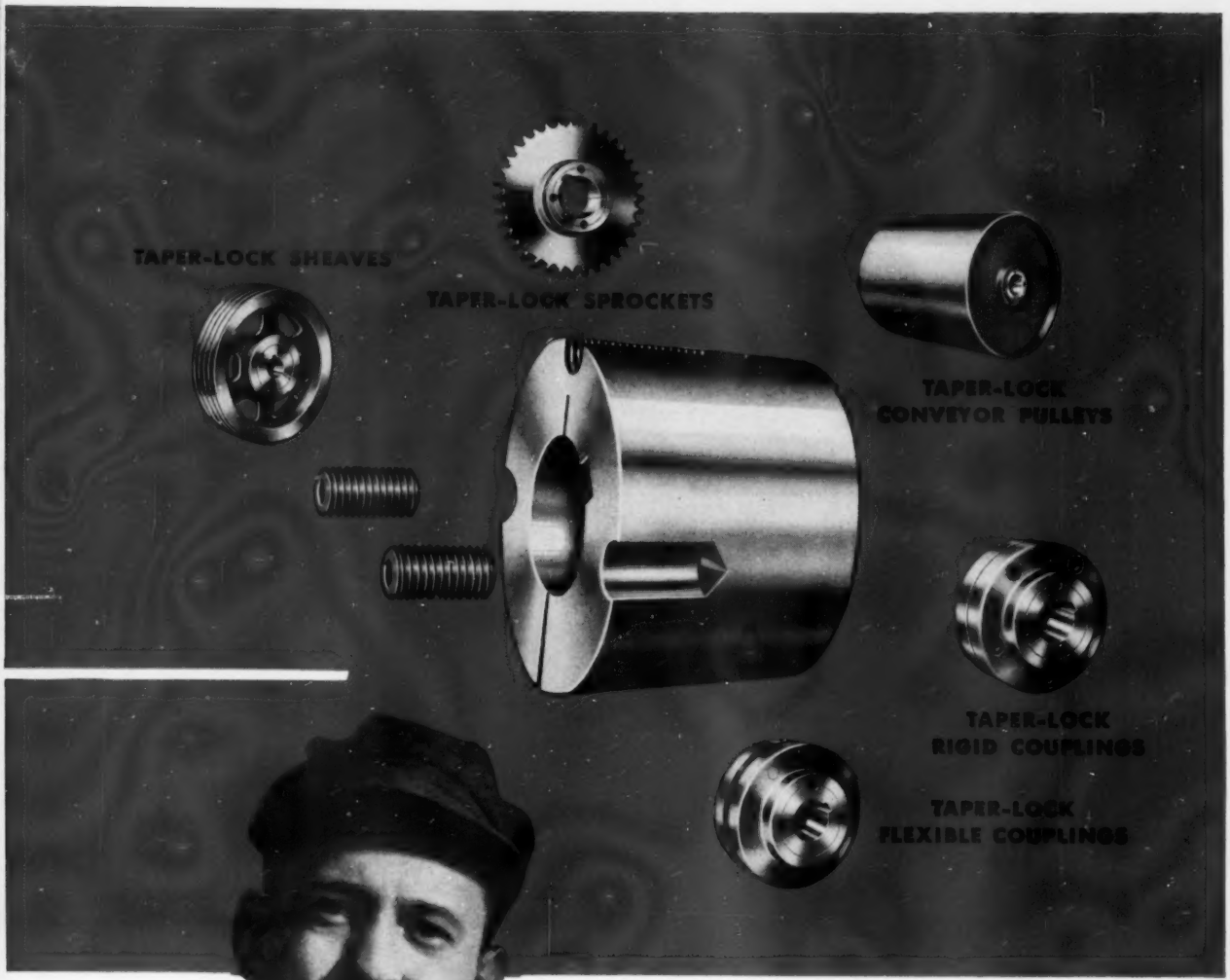
Taper-Lock, a patented product of Dodge, provides the simplest, surest means of mounting wheels on shafts. Dodge Taper-Lock products slip onto the shaft easily, quickly—hold with the firmness of a shrunk-on fit. They come off easily—no hammer, no crowbar, no shock to bearings of machinery.

Taper-Lock bushings fit in every one of the Dodge products pictured above. You can shift from a sprocket to a sheave, for instance, and use the same bushing. And Taper-Lock bushings are available in a range of sizes which makes changing from one size shaft to another equally easy and quick.

With a few Taper-Lock bushings you can make quicker changes and cut down-time on production machines. Get the facts now.



DODGE MANUFACTURING CORPORATION, 3200 UNION STREET, MISHAWAKA, INDIANA

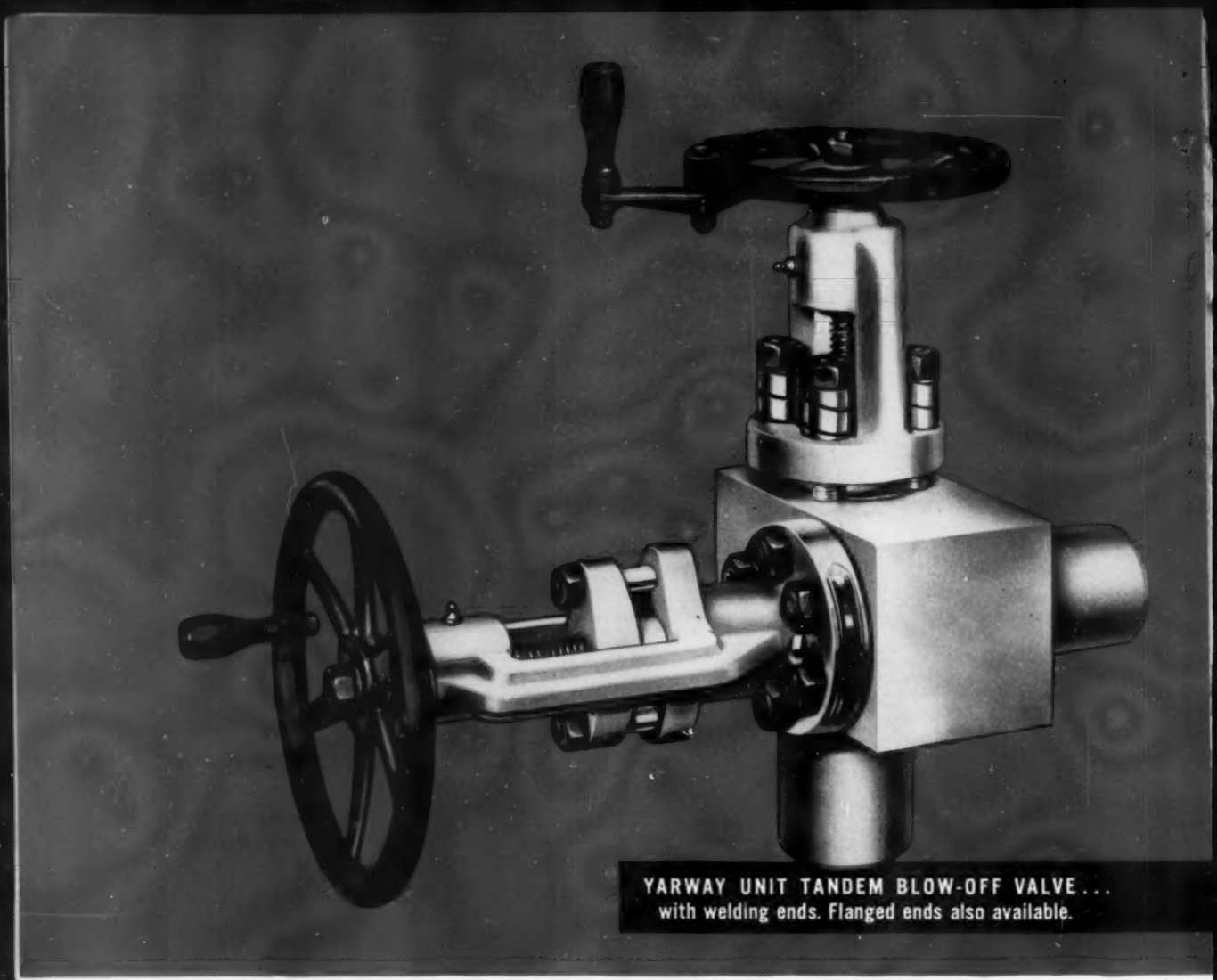


THERE'S ONLY ONE TAPER-LOCK, THE BUSHING THAT MOUNTS FLUSH!

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor, for valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified phone book, or write us.



YARWAY UNIT TANDEM BLOW-OFF VALVE . . .
with welding ends. Flanged ends also available.

BUILT TO "TAKE IT" AT

HIGH PRESSURES

● As boiler pressures go up . . . so does the demand for Yarway Unit Tandem Blow-Off Valves. *Why do more than 4 out of 5 high-pressure boiler plants now use Yarway Blow-Off Valves?*

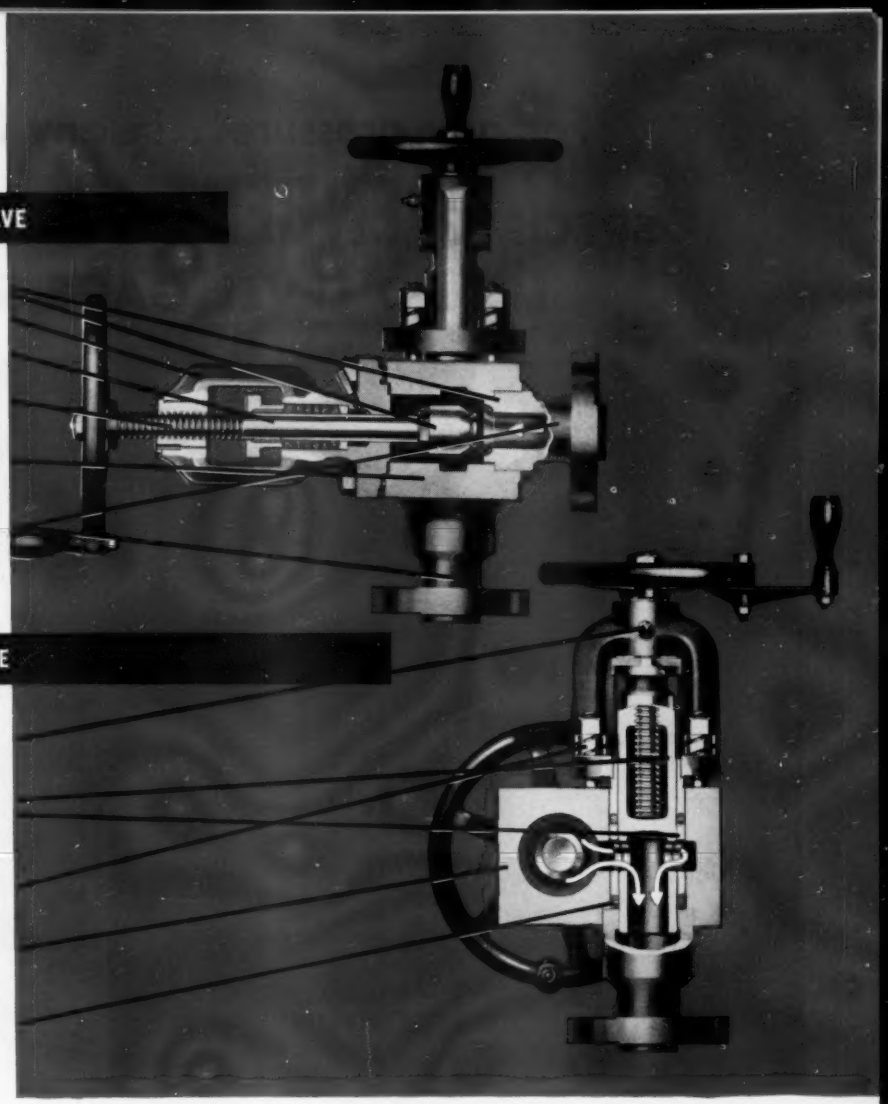
Yarway Unit Tandems are designed for strength, built to safeguard lives and investments, and to withstand severest acid-wash service.

A rugged, compact one-piece forged steel block serves as the space-saving common body for both valves, eliminating intermediate connections. Stelliting on seats and discs in the hard-seat valves provides longer life and better service. Balanced sliding plungers do the same on the seatless-type valves. Other design and metallurgy features add a high safety factor.

A FEW TYPICAL USERS

UTILITIES

Philadelphia Electric Company
Pacific Gas and Electric Company
Dallas Power and Light Company
Boston Edison Company
Cleveland Electric Illum. Co.



HARD-SEAT (Blowing) VALVE

Stellited and ground disc and seat.

Cast Steel Yoke.

Stainless steel stem.

Alemite lubrication (fitting on yoke hub) of stem and bushing threads.

One-piece forged body of carbon steel. Carbon-moly steel available on request.

Inlet and outlet nozzles welded into body. Flanged or welding ends provided.

SEATLESS (Sealing) VALVE

Alemite lubrication of plunger and ball thrust bearing in yoke.

Nitralloy plunger and lower follower gland. Stainless steel plunger and Ni-Resist gland available for acid wash service.

Yoke springs maintain required pressure on packing at all times.

One-piece forged body of carbon steel. Carbon-moly steel available on request.

Laminated lower packing ring with stainless steel reinforcing inserts.

Unit Tandems are available in the hard seat—seatless valve combination for pressures to 1500 psi, or in the hard seat—hard seat combination for pressures to 2500 psi. Both provide positive opening and closing with drop-tight shut-off.

Write for Yarway Bulletin B-434.

YARNALL-WARING COMPANY

100 Mermaid Avenue, Philadelphia 18, Penna.

BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY® blow-off valves

INDUSTRIAL PLANTS

Toledo Edison Company
Georgia Power Company
Union Electric Co. of Missouri
Rochester Gas and Electric Co.
Indianapolis Power and Light Co.

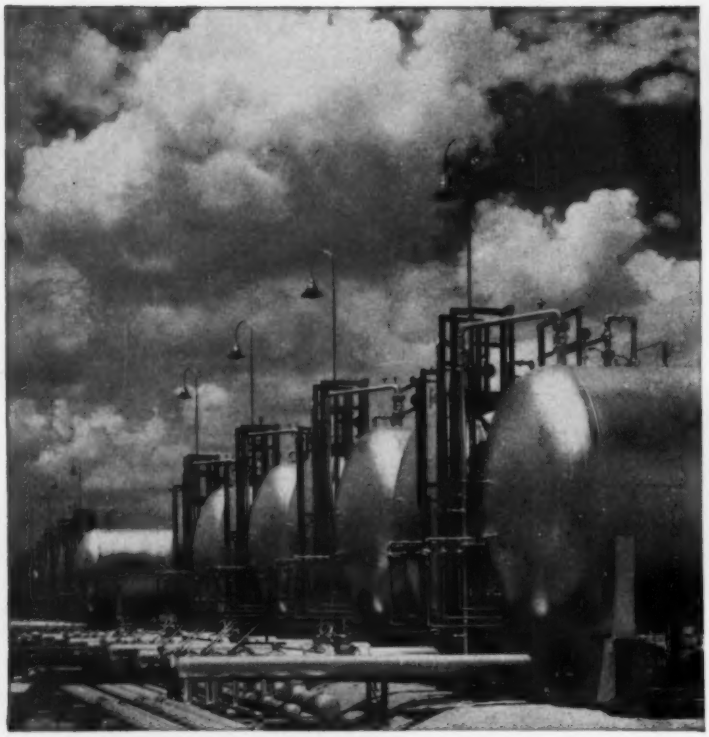
Bethlehem Steel Company
Ford Motor Company
Weyerhaeuser Timber Co.
Anheuser Busch Company
Procter & Gamble Company

Southern Kraft Corporation
Chrysler Corporation
Container Corp. of America
Eastman Kodak Company
American Viscose Company

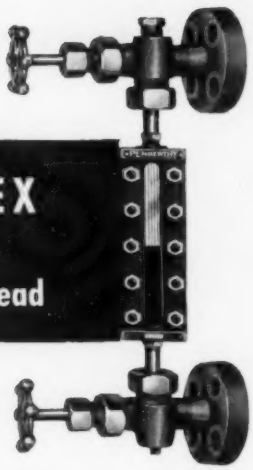
For any pressure... in any length

SPECIFY PENBERTHY

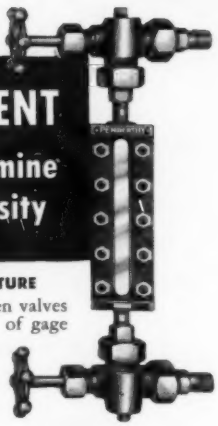
LIQUID LEVEL GAGE SETS



TUBULAR
Meets Navy specifications



REFLEX
Accurate, easy-to-read



TRANSPARENT
Quickly determine color and density

DON'T MISS THIS FEATURE
Union connections between valves and gage permit removal of gage without shutting down.

Corrosion-resisting Penberthy gages and valves indicate accurately the level in vessels containing any kind of liquid. Construction is exceptionally sturdy. Materials conform to or exceed requirements of A.I.S.I., A.S.T.M. and/or A.P.I.-A.S.M.E. for maximum recommended pressures and temperatures. They are made from carbon steels, high grade bronze and malleable iron. Also available are chrome-moly and stainless steels and Monel metal. When specified, materials such as acid bronze, Everdur, nickel and Hastelloy are supplied.

For your special requirements, experienced engineering counsel and service are available to design and make valves and gages to meet your unusual conditions.

● For most requirements, Catalog 35 is a handy help in selecting and ordering. A copy will be sent upon request.

Established 1886

PENBERTHY INJECTOR COMPANY

Division of the Buffalo-Eclipse Corporation

1242 Holden Avenue, Detroit 2, Michigan

There's Certain satisfaction in **PRODUCTS BY**

PENBERTHY

- CYCLING JET PUMPS
- EJECTORS
- INJECTORS
- ELECTRIC SUMP PUMPS
- EDUCTORS
- EXHAUSTERS
- SYPHONS

How to match your electrical system to production flexibility by:

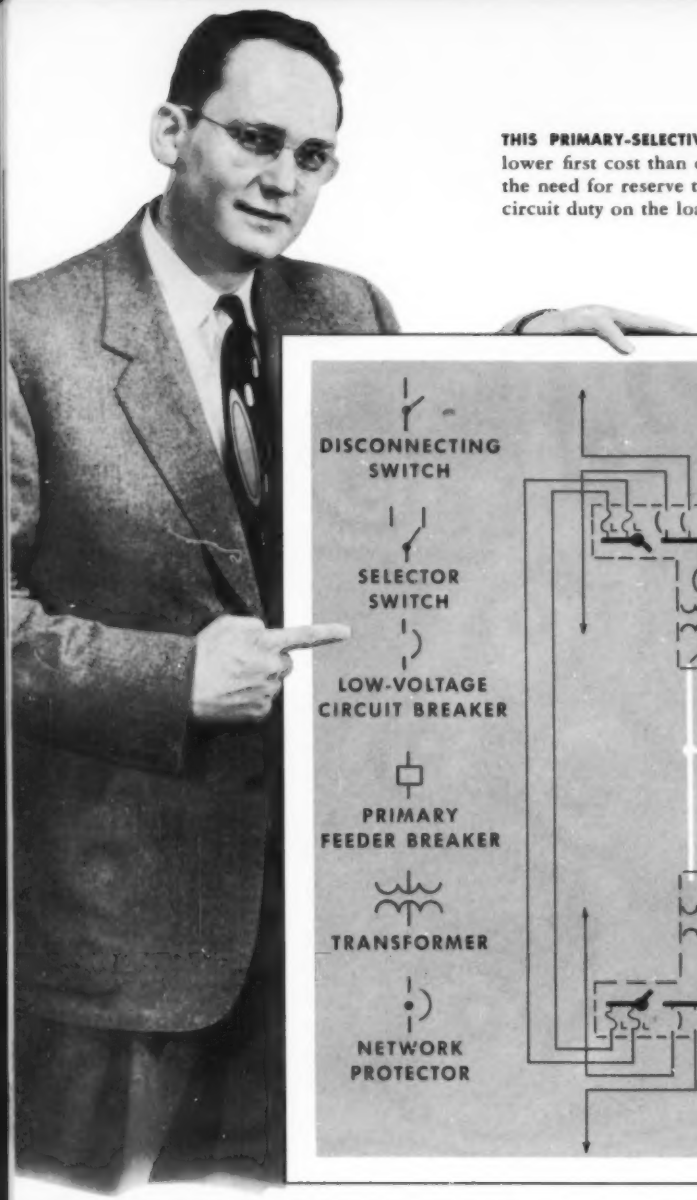
1. Engineering power distribution
2. Standardizing high voltage control
3. Getting power to the load quickly

Meet Joe Harris, Westinghouse Industry Engineering Manager, who presents some ideas on improving electrical system flexibility.

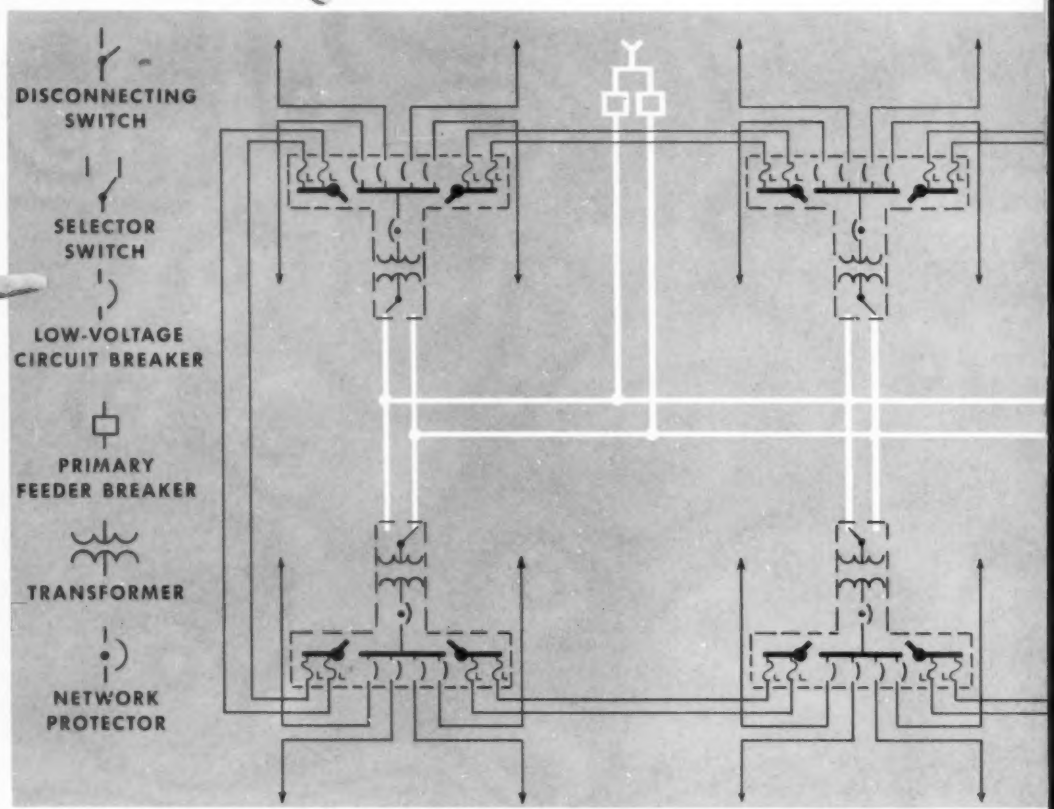
When you plan electrically for plant expansion or improvement, take advantage of Joe's wide experience in solving power distribution problems. It's part of the broad service your local Westinghouse representative offers in the talents of many design, engineering, and service specialists on the Westinghouse team.

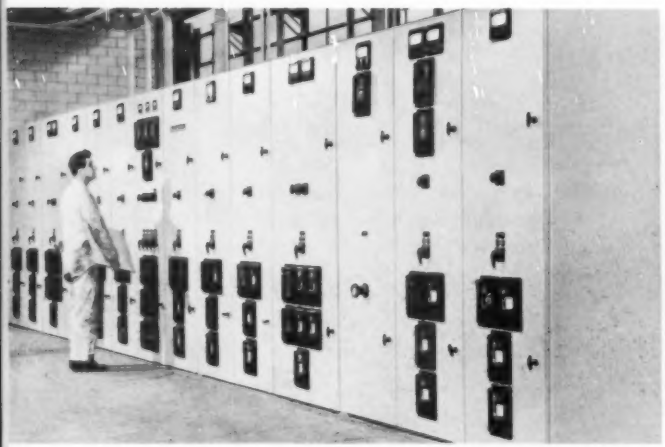
Next page, flexibility starts with engineered distribution . . .

Page 1 of 8 in this section

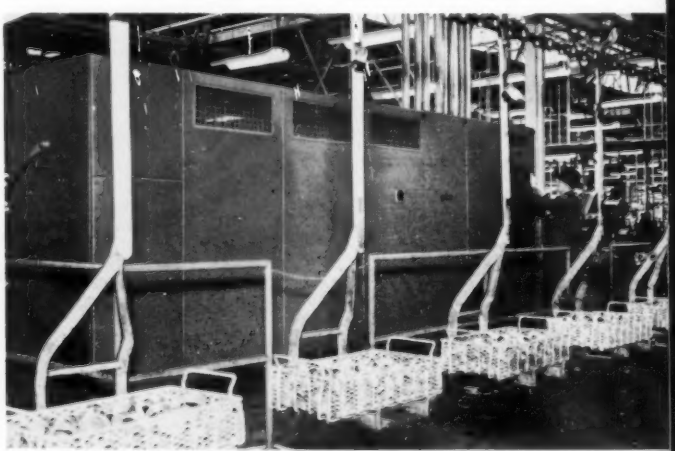


THIS PRIMARY-SELECTIVE NETWORK SYSTEM has the advantage of lower first cost than other types of networks because it reduces the need for reserve transformer capacity and reduces the short-circuit duty on the load circuit breakers.



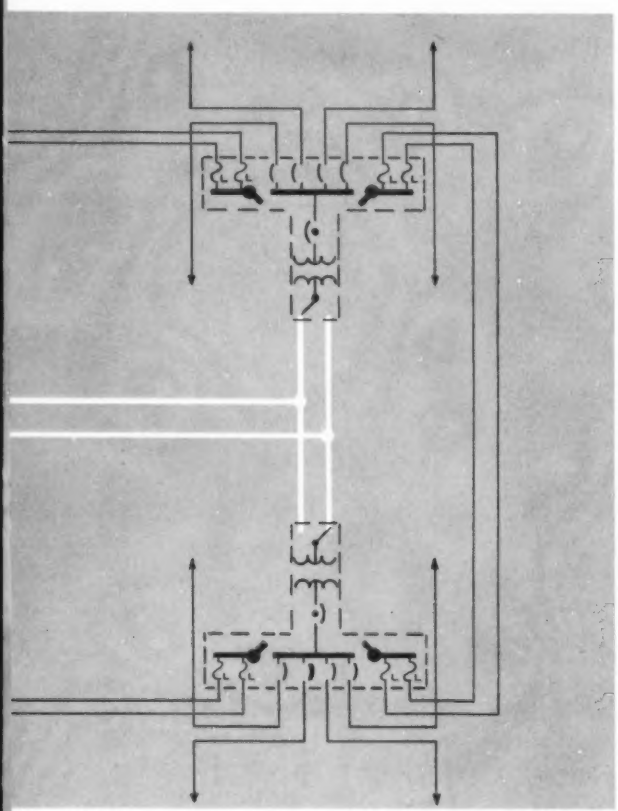


SWITCHGEAR IS EXPANDABLE in standard Westinghouse units. Standardized switchgear can be rearranged or relocated more easily to meet changes in future conditions. It also helps to speed maintenance and inspection.



HIGH VOLTAGE CLOSE TO THE LOAD is a cost-saving advantage you can achieve with Westinghouse power centers. They eliminate long, heavy secondary lines; save substantially on copper; lower line losses and improve voltage regulation.

Networks . . . one answer to flexibility, long-range planning

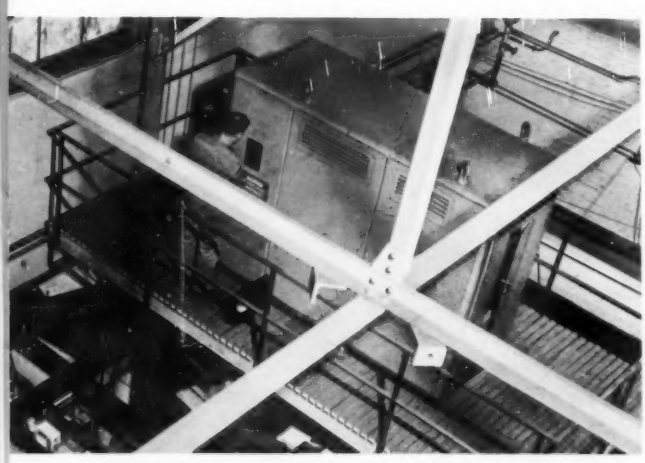


There are many excellent ways of distributing power in industrial plants. But if flexibility is your major requirement, you'll undoubtedly consider a network-type system. The slightly greater cost of a network system buys many immediate and long-term advantages. Network systems are easier to expand to handle increased power demands. Also this type of system is easily adapted to changing production needs which, in the long run, means economy.

Flexibility with this primary selective network system, for example, arises from the use of duplicate primary feeders—each capable of supplying the entire plant load. The feeder arrangement and the secondary-tie circuits permit the loads to divide among the power center, so that optimum voltage conditions are provided.

The ability to isolate any section of the system without disrupting service has obvious advantages. This permits maximum freedom in scheduling electrical maintenance or expansion, without disturbing operation of the plant. The network arrangement enables you to extend the system in any direction—at any time—with minimum rewiring and production loss.

Through the coordinating ability of your Westinghouse representative, you can take advantage of the wide experience that Westinghouse offers in engineering flexible power distribution. Coordinating equipment planning, manufacture, shipment, installation and servicing are all a part of the power distribution job handled by your Westinghouse representative. Call on him for help at any time.



SPACE CONSERVATION is another advantage of Westinghouse dry-type power centers. You can install these compact lightweight Westinghouse units up out of the way of the working area—on balconies or roofs.

YOU CAN BE **SURE** . . . IF IT'S

Westinghouse

Standardized switchgear adds flexibility this way . . .

FLEXIBILITY THROUGH STANDARDIZED HIGH VOLTAGE CONTROL

For high voltage, one man can easily and quickly drawout this DH De-ion air circuit breaker for inspection or replacement. Since breakers of the same rating are physically interchangeable, new units fit without alignment troubles.

Convenient expansion or relocation with standardized metal-enclosed switchgear

To achieve truly flexible power distribution you need equipment that is as flexible as the system itself. Nowhere is this more vital than in switchgear equipment . . . the heart of your plant's electrical control.

Westinghouse switchgear achieves flexibility through standardized frame design and manufacturing techniques. Here's what this standardization means to you:

Easy expansion or relocation A minimum number of basic units, each performing an important function, meets all the requirements normally demanded of

More flexibility per dollar is possible with Westinghouse high voltage metal-clad switchgear because all your money goes into equipment. Special engineering is held to a minimum in standard components that can be assembled in any combination required.

YOU CAN BE SURE...IF IT'S

For low voltage DB De-ion breakers are unitized to allow easier expansion or rearrangement of secondary load circuits as plant requirements change. Drawout construction aids quick replacement and inspections.

switchgear. Expansion in plant facilities is met by simply adding the required switchgear units. Production changes affecting switchgear are accommodated by substitution and rearrangement of units. And since all electrical equipment and connections are completely self-contained, entire installations can be picked up and reinstalled in another location or in another plant.

High voltage versatility Jig assembly of the breaker and stationary structure of high voltage metal-clad switchgear allows rearrangement of breaker units within the same structure. And since breakers of the same rating are interchangeable, conversion to a higher interrupting capacity can be accomplished with minimum expense.

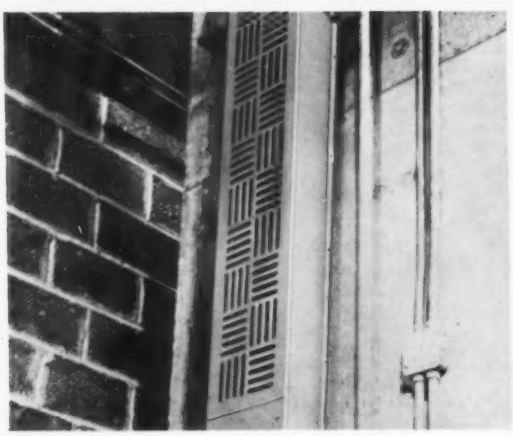
Low voltage service continuity Standardization means less production down time, too. Drawout, DB De-ion® breakers can be changed in three minutes flat. A spare breaker of the same rating can be substituted, and service continuity restored in short order.

Multi-purpose tripping provided only by Westinghouse low voltage DB De-ion air circuit breakers. Breakers allow delayed tripping on temporary overloads; trip on larger overloads before damage is done and trip instantly on short circuits.

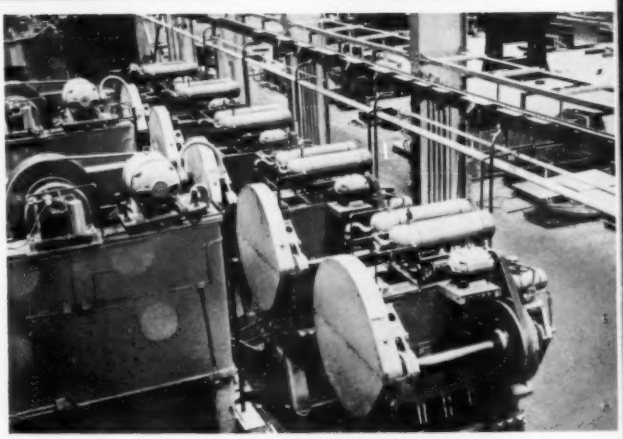
Next page, flexible equipment gets power to the load quickly . . . →

Westinghouse

From switchgear . . . Power is fed directly to the plug-in duct mounted in convenient location. With drop rods in position, duct goes up in a hurry, slide cantilever hangers to position and tighten.



To branch runs . . . This 2000 ampere, low-impedance riser carries power to the upper floors. Note the use of spring suspension hangers which compensate for expansion of duct . . . allow simple installation.



To machines . . . Six power take-offs in six feet of Westinghouse bus duct spell power flexibility for any plant. Plug-in receptacles are provided for circuit breakers, safety switches, and cover-operated fusible units.

Bus duct meets changing load requirements easily

Where system flexibility really pays off is in getting power from switchgear to your production equipment. For this reason alone, bus duct is one of the best investments you can make in secondary distribution.

Unequaled flexibility—Power can be taken off plug-in duct at one-foot intervals for maximum convenience. Plants can be retooled, buildings revamped without rewiring because bus duct can be readily relocated and installed easily, around obstructions, in any layout.

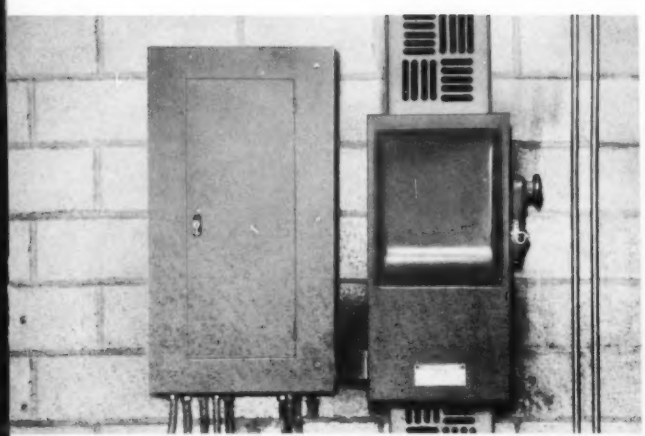
Costs less to install—Prefabricated in sections, bus duct goes in faster than cable and conduit. Savings in installation frequently reduce the original cost below that of any other secondary power distribution equipment.

Power for future loads—Bus duct spells future savings when building alterations and improvements add to power load. It provides important reserve capacity, and what's more, is readily salvageable, dismantled, reassembled, and expanded.

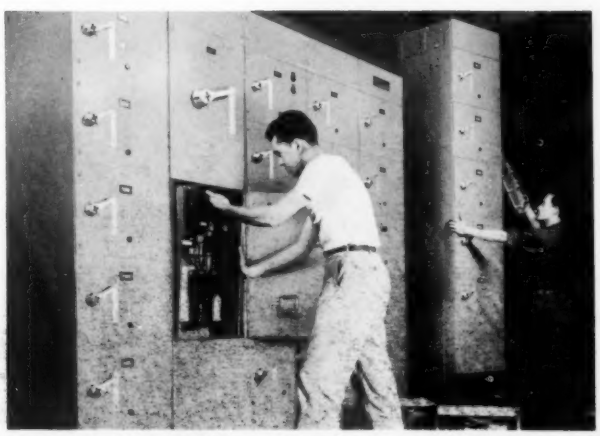
More power per dollar—Up to 5000 amperes, bus duct has greater current-carrying capacity, pound for pound, than any system of wireway or cable and conduit. There are four Westinghouse types: plug-in duct with service outlets for branch runs; low-impedance duct with low voltage drop for long feeder runs; weather-proof duct for outdoor installations that is available in feeder duct; and weatherproof duct in low-impedance duct.

YOU CAN BE **SURE**...IF IT'S

Westinghouse



To panelboards . . . Power is taken from plug-in duct. Additional circuits can be added with ease to Westinghouse Add-a-Circuit Panel, simply plug in the contact and wire up the terminals.



Control center expansion . . . Westinghouse control centers save frequently as much as 40% in installation costs over decentralized methods of mounting motor control. Saves time in inspecting control and reduces servicing problems.

Next page, how Westinghouse field engineering serves you . . . ⟶

Westinghouse field service adds a working partner to your team . . .

Westinghouse field engineers are trained to know product and industry problems. When you call on their application know-how, they become a working partner to your engineering and manufacturing personnel, consulting engineers and contractors. It removes your engineering staff from detailed planning.

Simplifies ordering problems . . . Westinghouse coordinates all manufacturing and shipping schedules to deliver matched equipment to the job at the right time. Fast delivery of genuine Westinghouse renewal parts from stock in 31 locations enables you to reduce parts inventories at your plant.

. . . and helps maintain power system flexibility

Thirty-eight large, well-equipped Manufacturing and Repair Plants are available to you for maintenance jobs on all types of electrical apparatus. These apparatus repair plants are spotted in key industrial areas to provide factory-type repairs at a local level.

* * * *

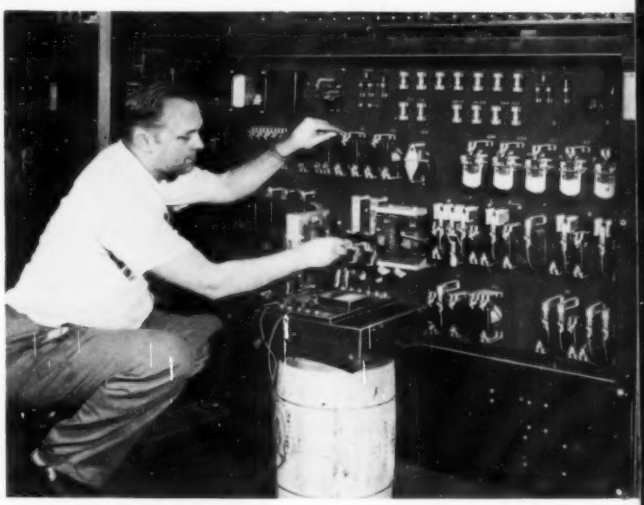
For further information on the products or services discussed in this section or for a copy of the literature listed here, call your local Westinghouse representative, or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

Ask For . . .

High-Voltage, Metal-Clad Switchgear	B-5306
Low Voltage, Metal-Enclosed Switchgear	B-5282
Dry-type Transformers	B-5920
Bus Duct	B-5835
AB-I Circuit Breakers	B-5456
Safety Switches	B-5457
Panelboard Planning	B-5260A
Control Centers	B-5621
Capacitors	B-3966A
Current Limiting Reactors	B-5918
Preventive Maintenance Booklet	B-5477

. . . and ask for a showing of the 20-minute film "Selecting The Right Industrial Distribution System".

56 Field Engineering Service Offices help speed completion of power system engineering, installation or modernization. Skilled Westinghouse engineers work with your personnel to coordinate product application.



Field Service Engineers are always ready to make quick inspections, adjustments and on-the-spot repairs for equipment that cannot be moved easily to one of thirty-eight Westinghouse Manufacturing and Repair Plants. MP-3014

YOU CAN BE SURE...IF IT'S Westinghouse

...from billet to tube to fitting

From this modern control room, every step in the heating, piercing, rolling and reduction of seamless tubes is closely monitored. This is typical of the highly specialized equipment demanded by the Globe precision process . . . insuring high quality and close tolerances.

GLOBE highly specialized process controls are used to produce the finest in WELDING FITTINGS

For complete information on the finest welding fittings available anywhere, send for the Globe Welding Fittings Catalog.

Globe precision-process manufacture *begins with the billet* — continues through the making of the seamless steel tube — (Globe alone among welding fitting manufacturers produces seamless steel tubes) — and extends through to the production of the finished fittings.

Because Globe has highly specialized controls — at every stage of manufacture *in its own plant* — you can be sure of uniform high quality seamless welding fittings when you specify Globe.

GLOBE STEEL TUBES CO.
MILWAUKEE 46, WISCONSIN

Chicago, Cleveland, Detroit, New York, Philadelphia, St. Louis, Denver, Houston, San Francisco, Glendale, Cal.

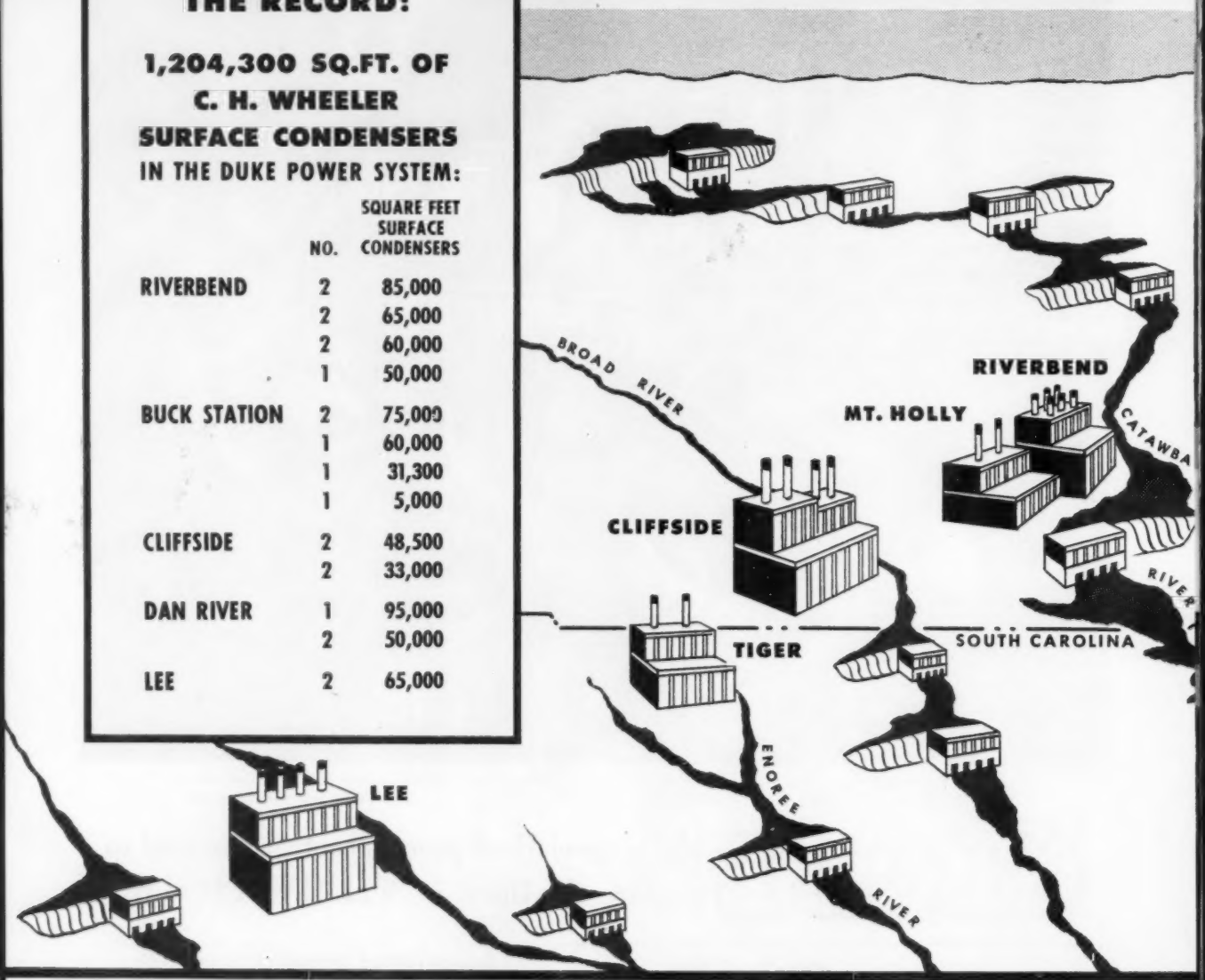
Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high purity ingot iron) seamless tubes — Globe Welding Fittings.

DUKE POWER *picks*

THE RECORD:

1,204,300 SQ.FT. OF C. H. WHEELER SURFACE CONDENSERS IN THE DUKE POWER SYSTEM:

	NO.	SQUARE FEET SURFACE CONDENSERS
RIVERBEND	2	85,000
	2	65,000
	2	60,000
	1	50,000
BUCK STATION	2	75,000
	1	60,000
	1	31,300
	1	5,000
CLIFFSIDE	2	48,500
	2	33,000
DAN RIVER	1	95,000
	2	50,000
LEE	2	65,000

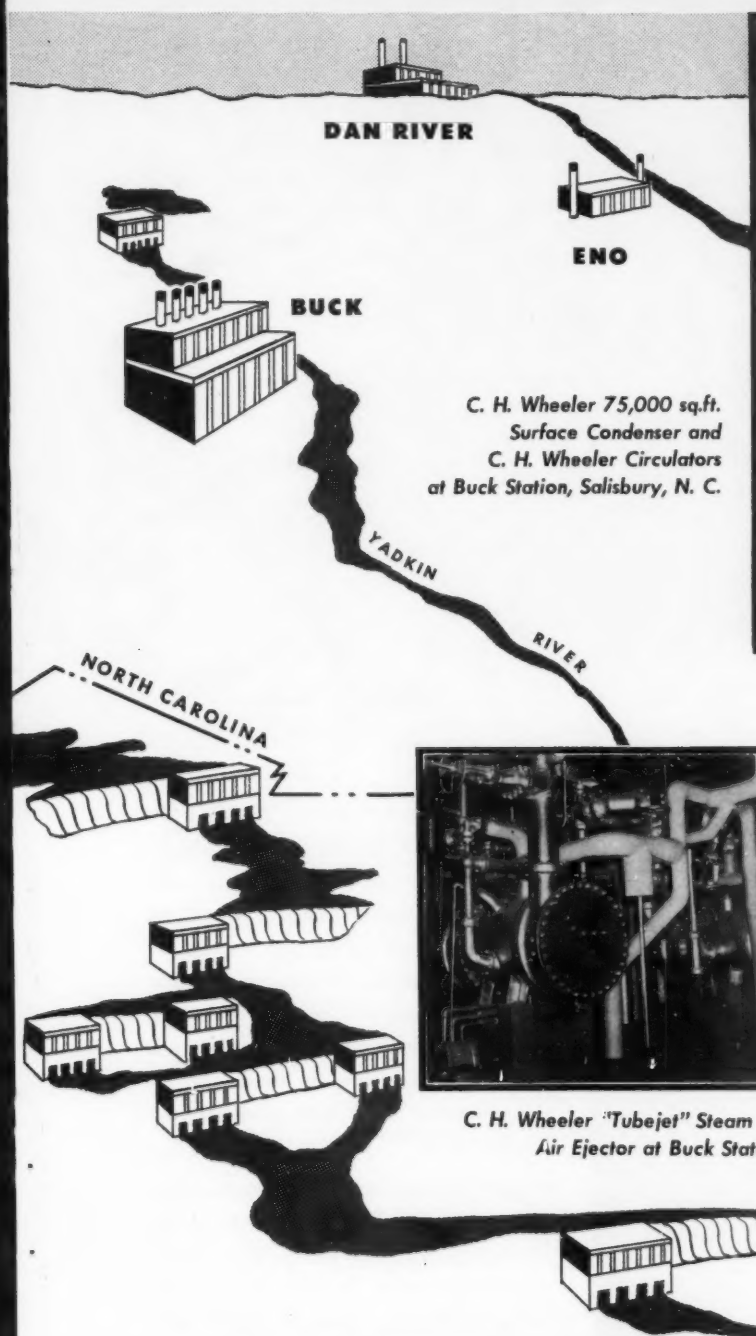


C. H. Wheeler Steam Condensers, Air Ejectors, Circulating and Condensate Pumps are tried and trusted equipment in every new steam power generating station that Duke Power has built. Photos show some of the latest installations in the new Buck Station where five C. H. Wheeler Surface Condensers are installed, ranging in size from a 5000 sq.ft. house turbine unit to a 75,000 sq.ft. unit. All other steam stations on the Duke system are completely equipped by C. H. Wheeler. This equipment is designed to strike a sound balance between first cost, operating efficiency and maintenance costs.

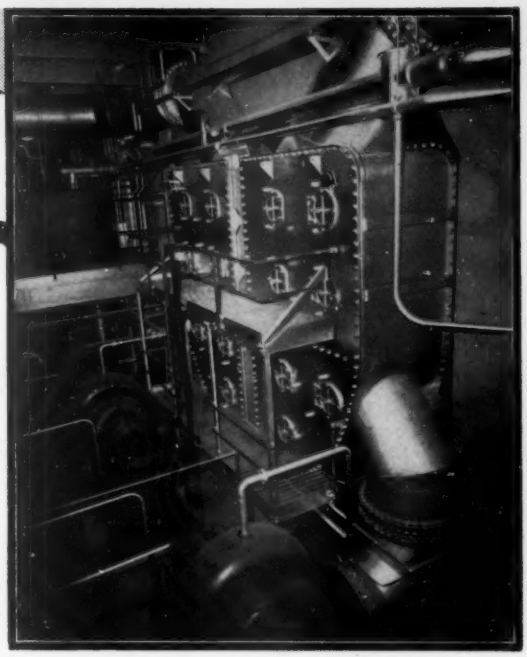
There's progressiveness in C. H. Wheeler engineering that matches the expansion plans of a great utility like Duke Power. A new 95,000 sq.ft. Surface Condenser Unit and auxiliaries is now being manufactured for Dan River Station.

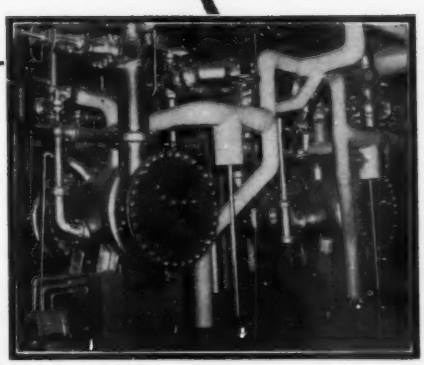
The art of condensing steam and producing vacuum for the prime movers of industry has the seasoning of 50 years of development at C. H. Wheeler. You can find no richer experience . . . no greater vision for the future of steam power generation . . . than at C. H. Wheeler of Philadelphia. . . . ***HOW MAY WE HELP YOU?***

C. H. WHEELER
STEAM CONDENSERS—AIR EJECTORS
CIRCULATING AND CONDENSATE PUMPS

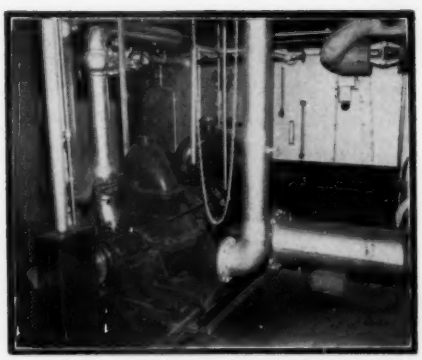


C. H. Wheeler 75,000 sq.ft. Surface Condenser and C. H. Wheeler Circulators at Buck Station, Salisbury, N. C.





C. H. Wheeler "Tubejet" Steam Air Ejector at Buck Station

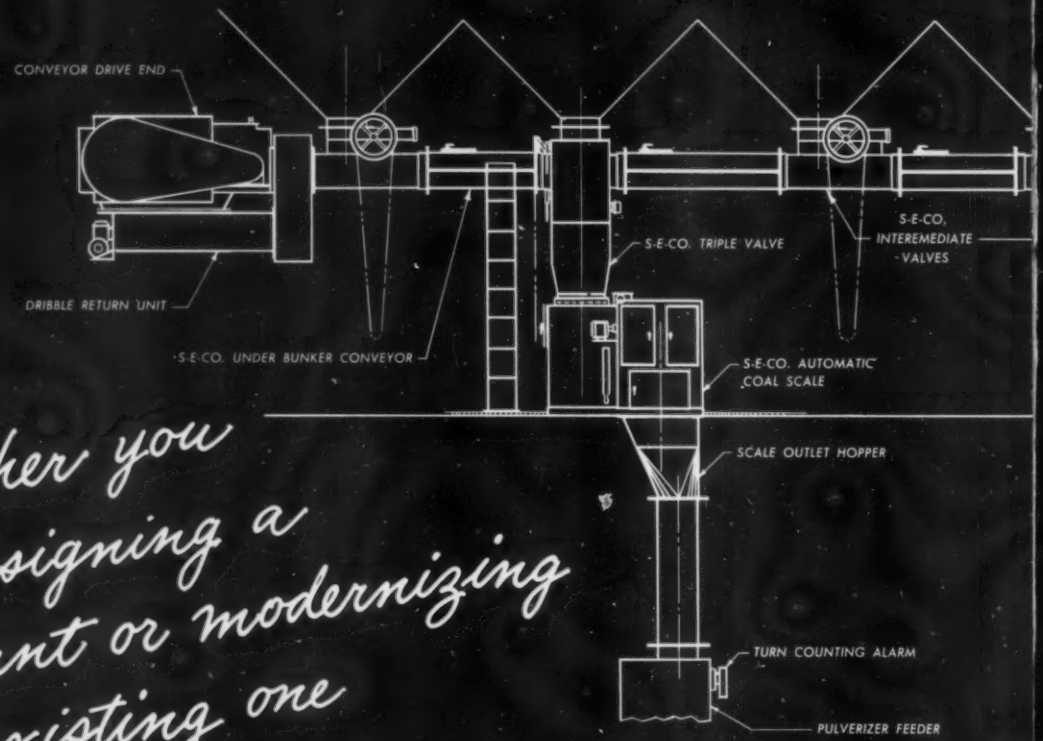


C. H. Wheeler 5-stage Condensate Pumps Operating on a Split Cycle System with a balancing standpipe between stages

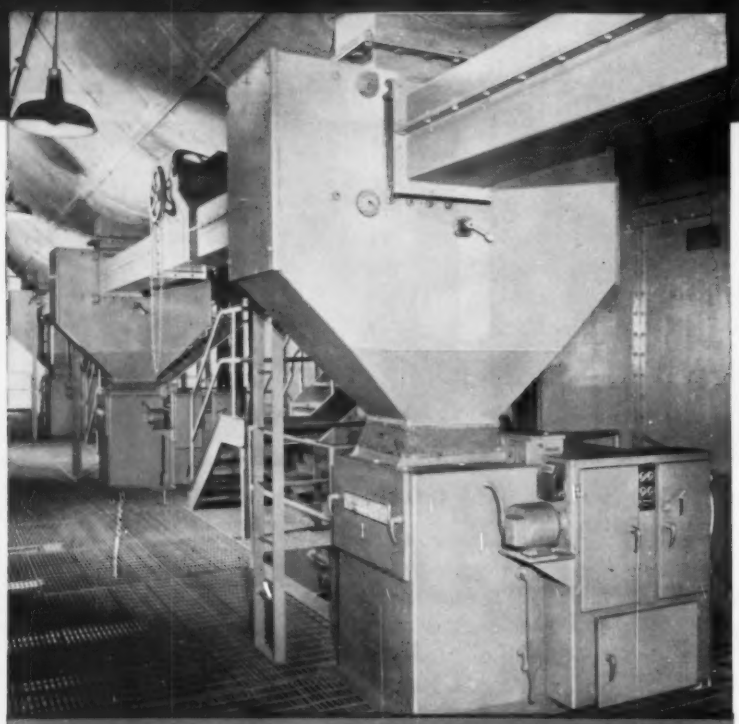
C. H. WHEELER *of Philadelphia*

C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Vacuum Refrigeration
High Vacuum Process Equipment • Micro-Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery



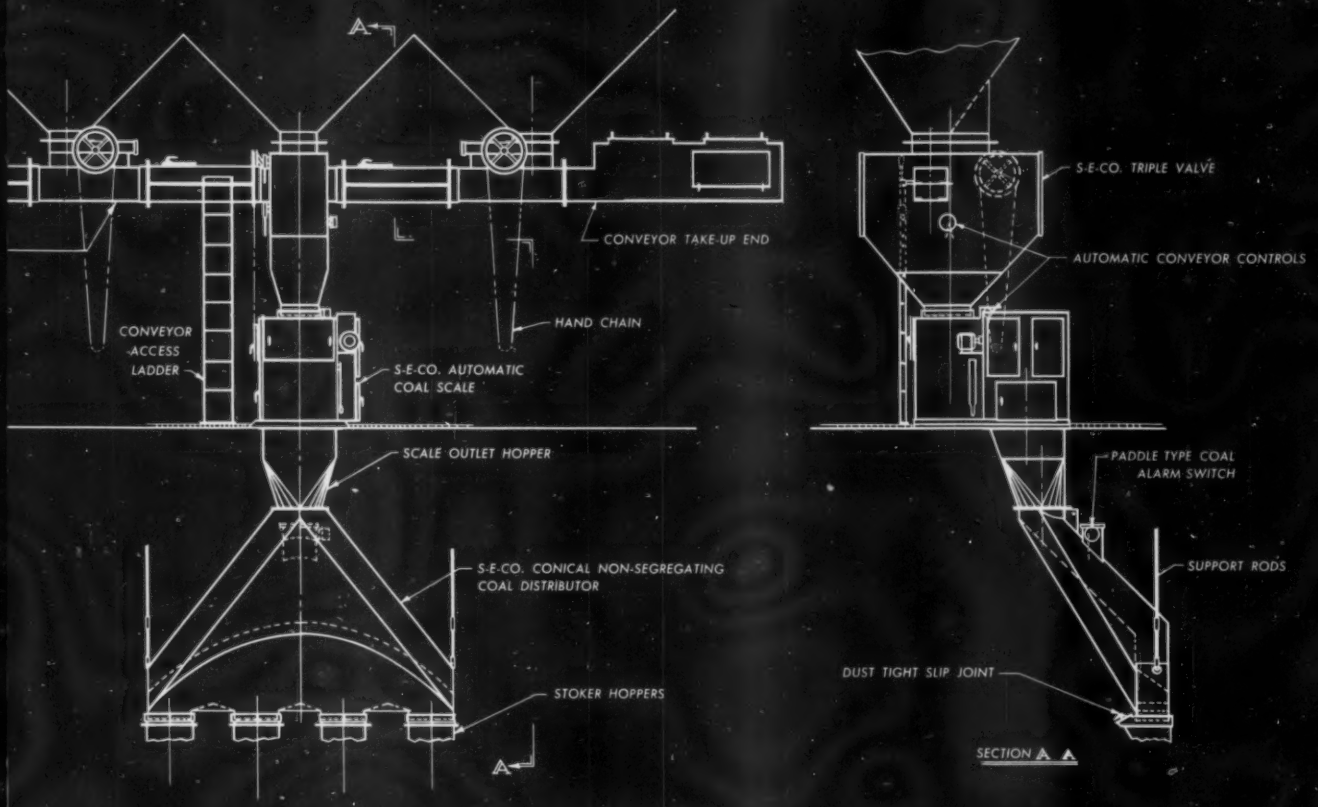
Whether you are designing a new plant or modernizing an existing one



S-E-Co. Under-Bunker Installation at J. E. Greenebaum Tanning Company, Milwaukee, Wisconsin.

STOCK EQUIPMENT COMPANY specializes in the design and manufacture of *Bunker to Pulverizer and Bunker to Stoker Installations* of the highest quality. Each job is carefully studied to provide an arrangement that will offer long life, reliable coal flow, and accurate weights of coal burned. Where stokers are involved, the arrangements also will prevent coal segregation.

Each S-E-Co. Job actually amounts to a custom built installation, using standard, jig-built components. These standard items include the S-E-Co. Coal Valve, Automatic Under-Bunker Conveyor, Paddle Type and Turn Counting Type Coal Alarms, Automatic Coal Scale and the S-E-Co. CONICAL Non-Segregating Coal Distributor.



THERE ARE SIX GOOD REASONS WHY YOUR LAYOUT SHOULD INCLUDE A S-E-CO. AUTOMATIC UNDER-BUNKER CONVEYOR

1. For automatic, dust-tight delivering and weighing of coal to any boiler from any bunker outlet.

2. Coal that would otherwise be dead between boilers is made available to any boiler.

3. Coal in bunker in front of boilers not on line is made available to boilers that are operating.

4. In providing means to move coal from any bunker outlet, the conveyor helps prevent bunker fires. Also helps prevent the coal from lying so long that it becomes set.

5. If coal in bunker catches fire, the conveyor can deliver it to all boilers in operation or discharge it from building through emergency outlet.

6. The S-E-Co. Under-Bunker Conveyor is of the highest quality — proven by many installations which have operated for many years.

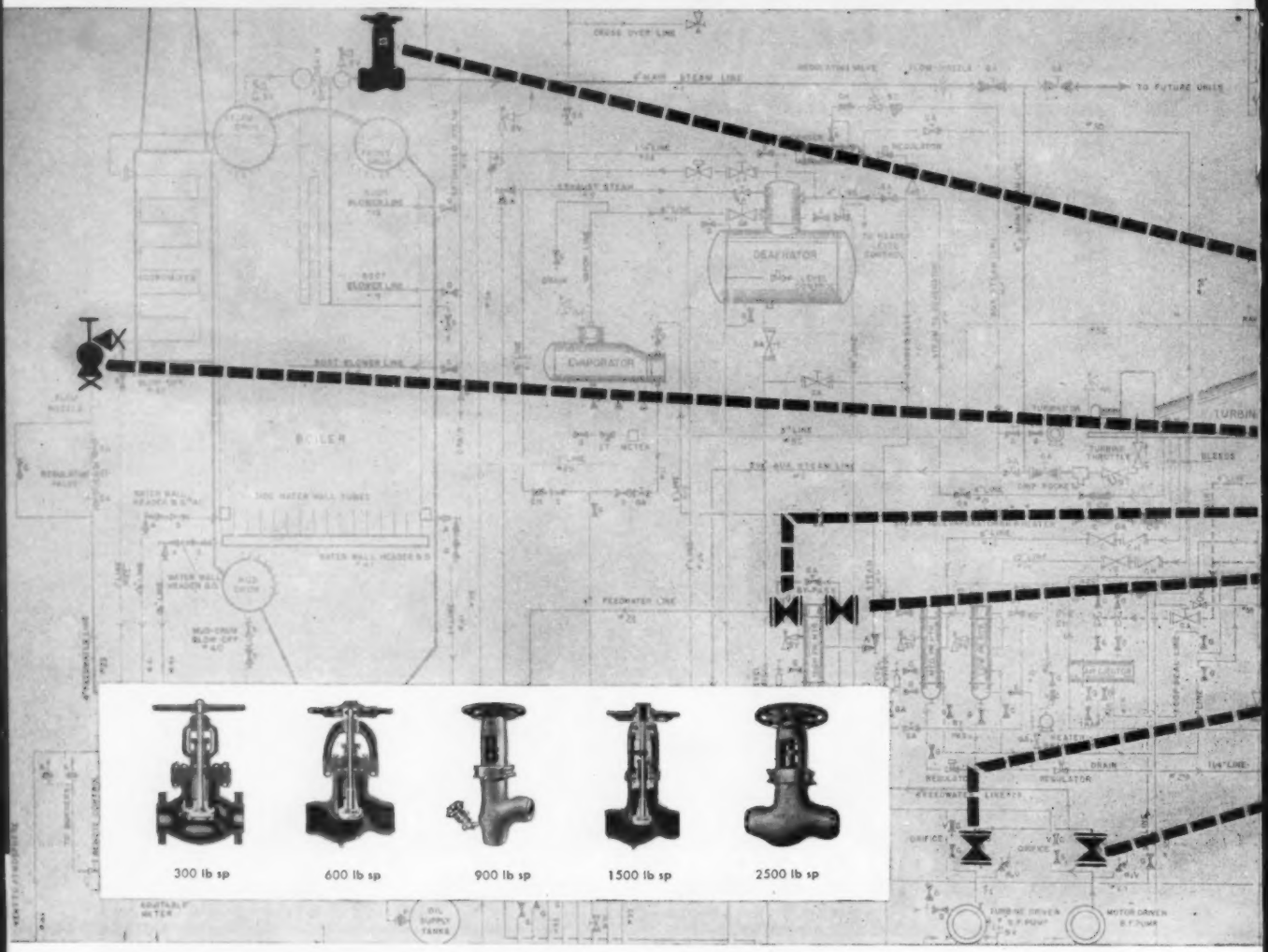
In the design of new plants, the above points allow the use of a more efficient bunker which can lower the overall building height without sacrificing any amount of coal available to the boilers.

In the modernization and expansion of existing plants, the Under-Bunker Conveyor provides a feasible means of using existing long, shallow bunkers to reliably feed new boilers which have replaced a number of much smaller boiler units.

For help with your layout, contact a local representative or write direct to:

STOCK EQUIPMENT COMPANY • CLEVELAND 15, OHIO

What you should know about



In modern high pressure steam generating plants, economy, dependability and safety in "stop valve" applications can be improved by proper selection of valves. Edward, long a pioneer in high pressure-temperature steam control, has discovered many "stop valve" facts. Here are a few of the more important.

SELECTION POINTERS . . . that reduce installation costs and increase operating efficiency.

1 For flexibility in installation select stop valves that effect positive shut-off in any position. (Guided disks in all Edward cast steel globe and angle valves seat perfectly regardless of installation position.)

2 Angle valves in place of elbows reduce piping and installation costs and often improve operating convenience.

3 Using modern type globe or angle valves rather than gate valves on feedlines is recommended for tightnesss, repairability, adaptability and other reasons. (Edward bulletin DB-E6 explains all the advantages gained by using modern globe valves in central station boiler feedlines. Ask for it.)

4 Where Boiler Code requirements permit use of stop valve instead of non-return valve at steam discharge outlet, consider globe or angle valve for dependable shut off for boiler or main steam line hydrostatic tests.

5 For new installations, repairability of stop valves is a significant consideration. In spite of the greatest care in erection, damage to seating surfaces may take place during first months of operation. Selection of easily repaired valves will reduce costs. (Edward globe and angle valve seats can be relapped quickly and easily.)

6 Pressure drop is important in selecting stop valves. Turbulence tends to increase wear. (Edward globe and angle valves with their streamlined interiors reduce pressure drop and turbulence to a minimum. Catalog 12-H gives the complete story.)

7 On large high pressure valves which are closed or opened infrequently, avoid the expense of costly geared or automatic operating mechanisms. (One man using the Edward IMPACTOR Handwheel can produce sufficient torque to seat a 12 in. valve with 2000 psi under the disk.)

8 In higher pressure-temperature steam generating plants, pressure-seal bonnet designs are rapidly replacing the cumbersome, heavily-bolted bonnets. Here are several especially desirable features:

(a) pressure-seal bonnet joints stay tight regardless of temperature-pressure variations;

(b) fewer bolts, lighter covers and bonnets save time and labor, reduce maintenance costs;

(c) lower pressure drop in streamlined pressure-seal designs permit use of smaller piping and valves . . . saving space, weight and costs;

(d) and pressure-sea' construction improves streamlining which reduces wear-inducing turbulence.

(Edward has built PRESSURE-SEAL valves for ten years and its continuing research has developed many new features that reduce maintenance and improve sealing qualities.)

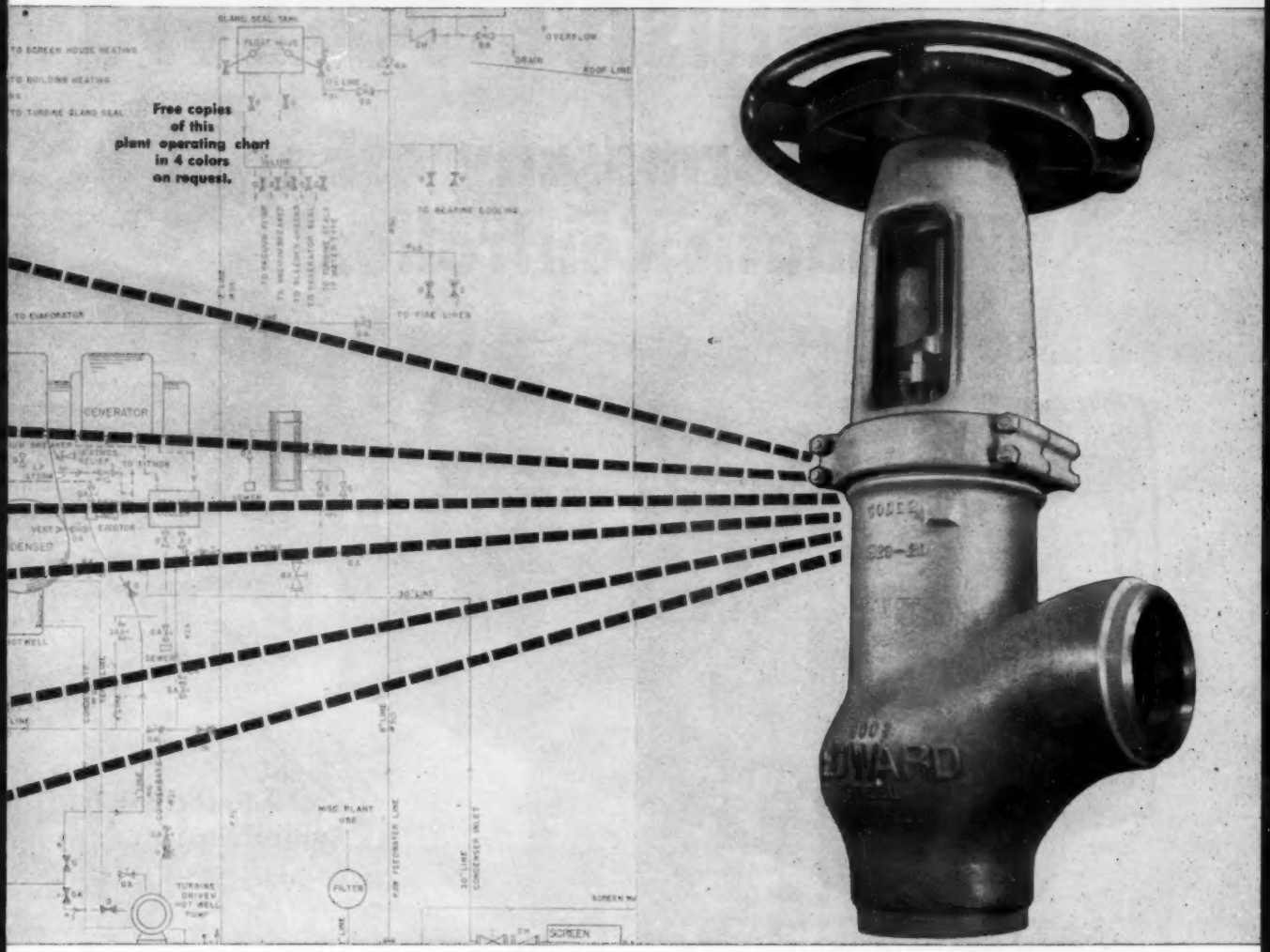
ASME BOILER CODE REQUIREMENTS . . . (excerpts)

that control high-pressure stop valves.

P-301

Each steam-discharge outlet, except safety-valve, reheater inlet and outlet, or superheater inlet connections, shall be fitted with a stop valve located at an accessible point in the steam-delivery line and as near to the boiler nozzle as convenient and practicable. In the case of a single boiler and prime mover installation, the stop valve required by the Code may be omitted provided the prime mover throttle valve is equipped with an indicator to show whether the valve is open or closed and is suitable to

CAST STEEL STOP VALVES*



withstand the required hydrostatic pressure test of the boiler.

A stop valve is not required at the inlet or outlet of a reheater or separately fired superheater.

P-302

All Stop valves and the fittings between them and the boiler shall be equal at least to the requirements of the American Standards given in Tables A-6, A-7, A-8, and A-11 for the maximum allowable working pressure and the temperature in service and material used.

The nearest steam stop valve or valves to the boiler drum or superheater inlet shall have a pressure rating at least equal to the minimum set pressure of any safety valve on the boiler drum at the corresponding saturated steam temperature.

The nearest stop valve or valves to the superheater outlet shall have a pressure rating at least equal to the minimum set pressure of any safety valve on the superheater and at the expected superheater steam temperature; or at least equal to 85 per cent of the lowest set pressure of any safety valve on the boiler drum at the expected steam temperature of the superheater outlet, whichever is greater.

P-303

When boilers are connected to a common steam main, the steam connection from each boiler having a manhole opening shall be fitted with two stop valves having an ample free-blow drain between them. The discharge of this drain shall be visible to the operator while manipulating the valve. The stop valves shall consist preferably of one automatic non-return valve (set next to the boiler) and a second valve of the outside-screw-and-yoke type; or, two valves of the outside-screw-and-yoke type shall be used.

P-304

When a stop valve is so located that water can accumulate, ample drains shall be provided. All drain lines, including pipe, fittings, and valves, shall comply with the requirements for steam piping or water piping according to the service.

P-317

(a) The feed pipe shall be provided with a check valve near the boiler and a valve or cock between the check valve and the boiler, and when two or more boilers are fed from a common source, there shall also be a globe or regulating valve on the branch to each boiler between the check valve and the source of supply. Wherever globe valves are used on feed piping, the inlet shall be under the disk of the valve.

(b) When the supply line to a boiler is divided so as to feed a drum in more than one place or to feed more than one drum it is recommended that each such branch line be equipped with a stop and a check valve even though the common source is equipped as required by (a).

(c) If a boiler is equipped with duplicate feed arrangements, each such arrangement shall be equipped as required by the rules.

(d) A combination stop-and-check valve in which there is only one seat and disk, and a valve stem is provided to close the valve when the stem is screwed down, shall be considered only as a stop valve, and a check valve shall be installed as otherwise provided.

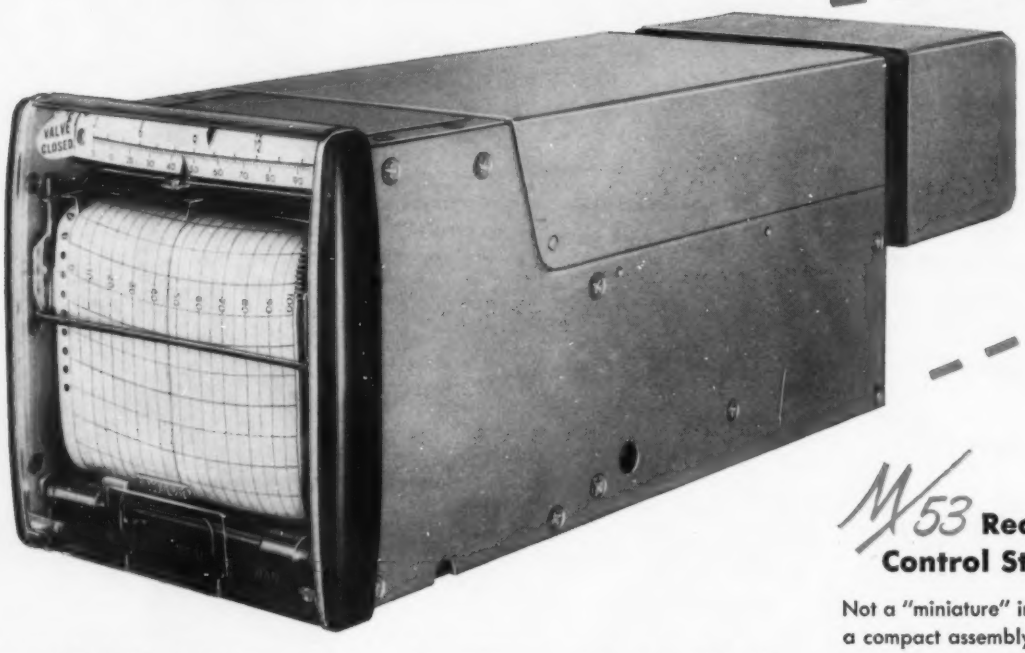
(e) Where an economizer or other feedwater-heating device is connected directly to the boiler without intervening valves, the feed valves and check valves required shall be placed on the inlet of the economizer or feedwater-heating device.

**Only a few of the most important stop valves are highlighted in this illustration.*

Edward Valves, Inc.
Subsidiary of ROCKWELL MANUFACTURING COMPANY
1220 W. 144th STREET
EAST CHICAGO, INDIANA
Another Product.

This exclusive Foxboro

outperforms any other Automatic Controller!



M/53 Recording Control Station

Not a "miniature" instrument, but a compact assembly of full-size component parts with no compromise in accuracy or convenience. *Features:* continuous valve position indicator . . . fast, no-drift control point setting plus micrometer adjustment . . . no external knobs . . . full 4" width, 30-day, easy-loading chart . . . several months' ink supply . . . single-switch automatic-manual transfer . . . additional measurement pen optional.

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller with M/53 Recorder on your process. The tougher the job, the more it will outperform other controllers!

Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this Foxboro component system has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

This Consotrol Controller-Recorder system is an entirely different and original concept of instrumentation, developed through knowledge gained in Foxboro's 30 years of control leadership. The exclusive floating disc live-balance controller, and the full size 4"-chart recorder, are combined in an ultra-compact yet fully accessible 6" x 6" assembly. The result is unequalled ease of operation, repeatability of action, and uniform product quality.

Get complete facts on this remarkable advance in automatic control. Write for Bulletin 463, and ask your Foxboro representative for a demonstration.

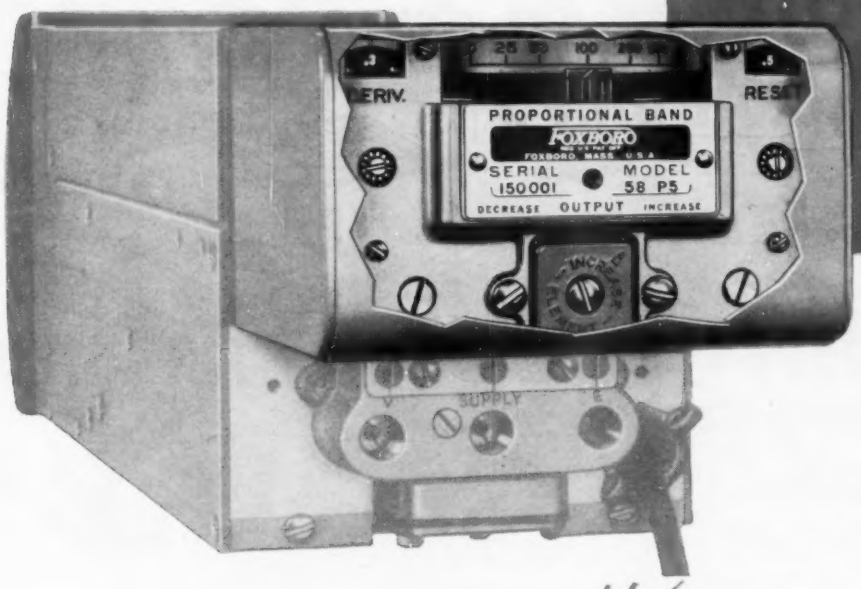
**Reg. U. S. Pat. Off.*

THE FOXBORO COMPANY, 685 NEPONSET AVE., FOXBORO, MASS., U. S. A.

FOXBORO

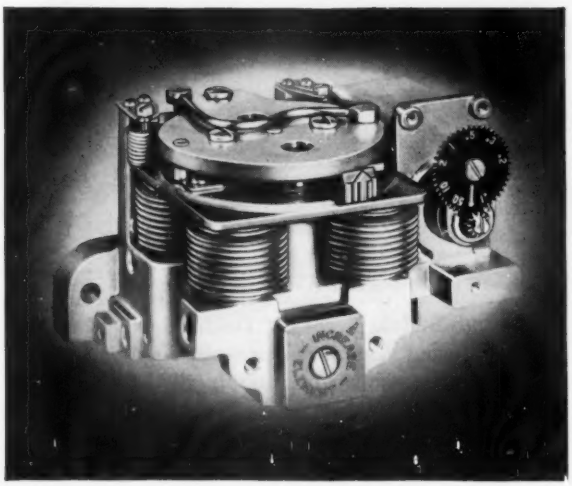
REG. U. S. PAT. OFF.

development



M/58 Controller

A remarkable design achievement, embodying the precision, sensitivity, and "live balance" of the exclusive floating disc. *Features:* no diaphragms . . . only one nozzle . . . only 19 parts . . . all four control functions available, including two ranges of reset . . . plug-in reset and derivative units. Can be integrally mounted with the M/53 as shown, or remotely located.



Revolutionary Design

Here's the high-precision Foxboro "floating disc" balancing system. Matched bellows provide stability and simplicity unapproached by other designs. Plug-in reset unit shown at right of assembly; derivative unit similarly plugs in at left. The lever-set proportional band adjustment is calibrated to 500%. This flexibility of function makes the M/58 adaptable to any process.

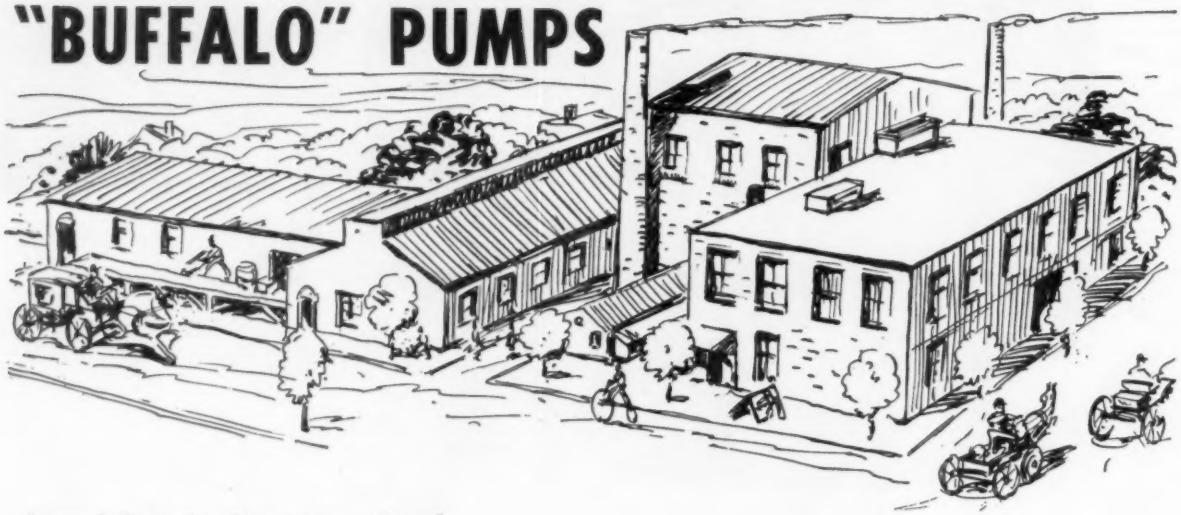
FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

CONSOTROL INSTRUMENTS

Since "WAY BACK WHEN"...

Industry has depended on

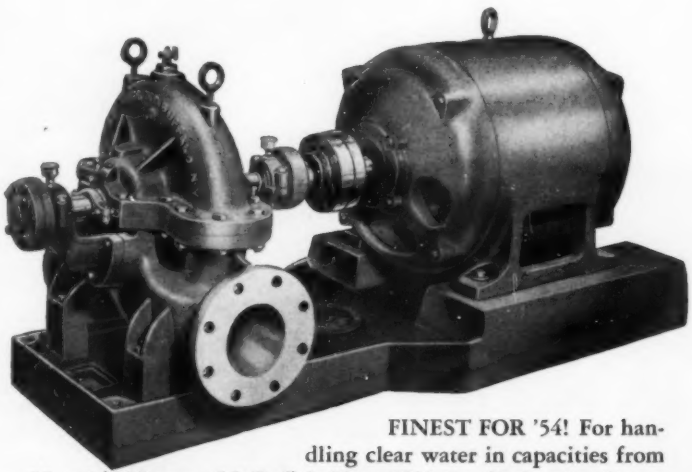
"BUFFALO" PUMPS



Long before electric motors, powered pumps, the then Buffalo Steam Pump Company was already building some of industry's most respected pumps. Respected, because "Buffalo" engineers and craftsmen started out to build pumps that *wouldn't* need a lot of attention and repairs—and would still be on the job twenty and thirty years later.

They've adhered to that idea ever since—passing their know-how on to their followers—always keeping close contact with requirements in the field—making never-ending improvements. Today, you can pick a "Buffalo" Centrifugal Pump with the full assurance that it embodies every known feature for the most efficient and trouble-free service possible.

Anyone can build a pump that will move a liquid. Yet, doesn't it make sense to buy the pumps of a manufacturer who has specialized in quality pumps, and pumps alone, since "way back when"?



FINEST FOR '54! For handling clear water in capacities from 10 to 14,000 gpm, this Buffalo Type "SL" Double Suction Pump has no equal for efficiency, easy maintenance and long life. Widely used in power plants, air conditioning and air washer service, paper and textile mills. Write for Bulletin 955-P.

"Buffalo" PUMPS

BUFFALO PUMPS, INC.

488 BROADWAY BUFFALO, NEW YORK

Subsidiary of Buffalo Forge Company
Canada Pumps, Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities.

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

SOLVING WATER PROBLEMS in Cooling Towers

Use of cooling towers to save on water brings unusual problems. Some of these problems are corrosion, scaling, algae and slime, and deterioration of wood in the tower. Allis-Chalmers recently published an informational bulletin, Number 47A, which explains the causes of these problems and what can be done about them.

Part of Practical Library

This bulletin is one of a series published by Allis-Chalmers to help you understand the causes and solutions of many water problems. It is the result of Allis-Chalmers experience solving water problems for every industry, in addition to solving problems involved in the company's own broad line of steam turbine and power plant equipment.

Complete Water Conditioning Service

Allis-Chalmers offers complete water conditioning service. You can get analyses and reports on your problems. You can get chemicals needed in water treatment. And you can get the equipment needed for any system.

A-4316

Get Information — For your copy of Bulletin 47A on water treatment for cooling towers, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby A-C district office to have an Allis-Chalmers water conditioning engineer consult with you on your problems.

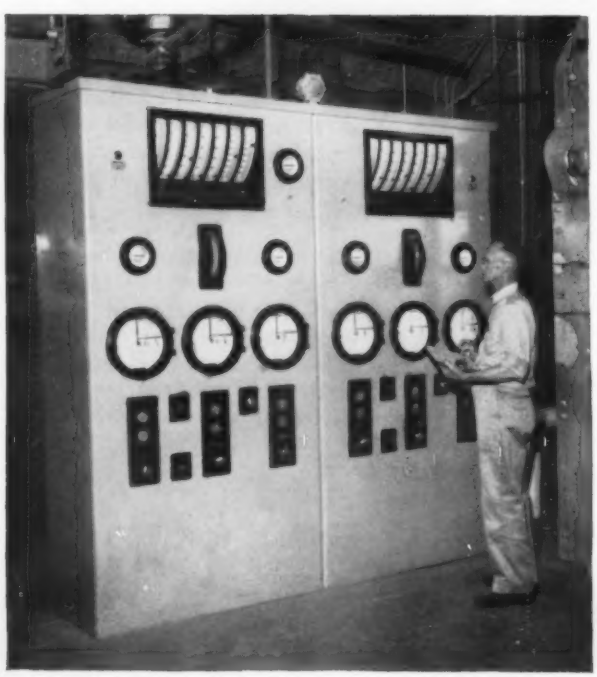
ALLIS-CHALMERS

Boiler room at Kansas State College. Republic instrument panel is at left. Boilers are arranged for either gas or oil firing.

REPUBLIC *Automatic*

COMBUSTION CONTROLS

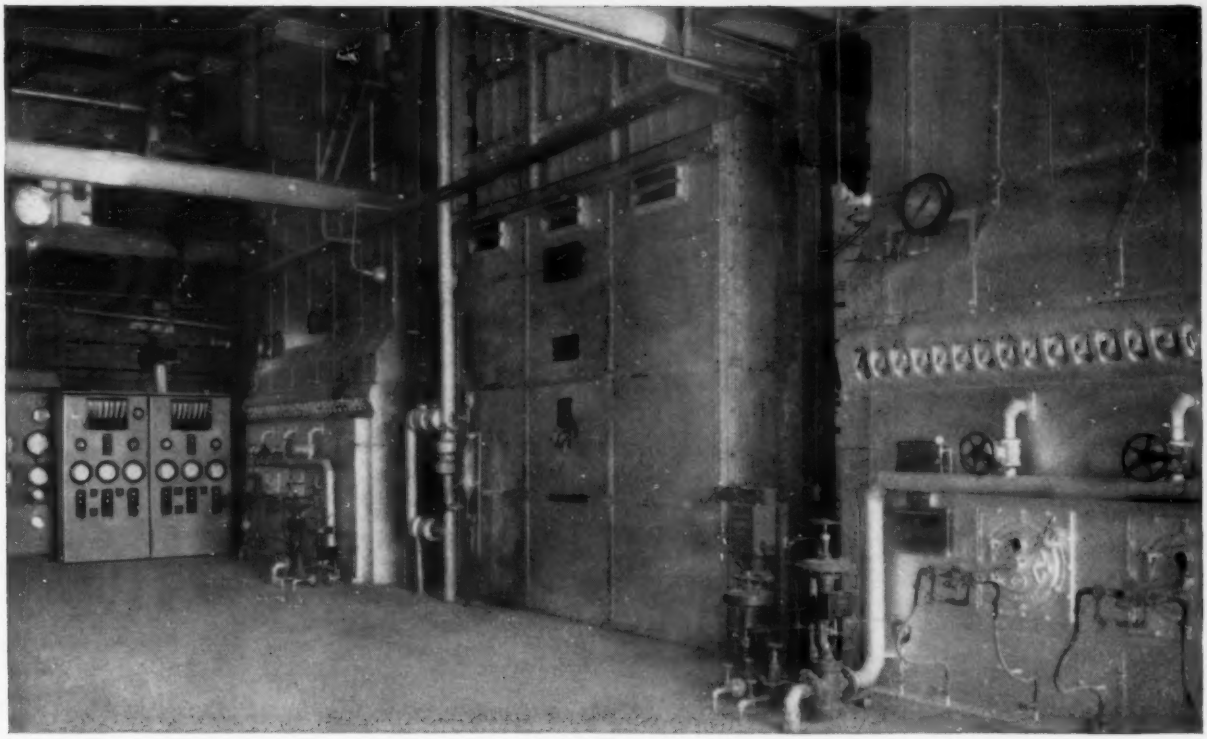
Go to College to



● At Kansas State College, a complete Republic combustion control system, feedwater level controls and instruments automatically operate two 50,000 pounds per hour boilers for maximum combustion efficiency. Fired by either oil or gas, these boilers generate steam at 225 psig and 500° F.

With Republic automatic combustion controls in this power plant, all loads,

Instruments on the control panel monitor boiler operation. If desired, the entire combustion system can be operated manually from this panel.



Cut Steam Costs

including "peaks", are met smoothly with steam output exactly matched to demand. Fuel costs per pound of steam produced are kept at a minimum 24 hours a day, seven days a week. Maintenance costs are kept low, too, by *continuous* proper operation of the boilers.

Whatever the size of your boiler, its draft arrangement, type or types of fuel to be fired and load conditions to be met, there's a Republic combustion control system that can bring these advantages to you. Our engineering staff, with more than 37 years *specialized* experience in combustion control systems, is at your service to help you get the system that exactly meets your needs. For your convenience, there's a nearby Republic field engineer to bring you all the facts. Write and make a date to see him soon.

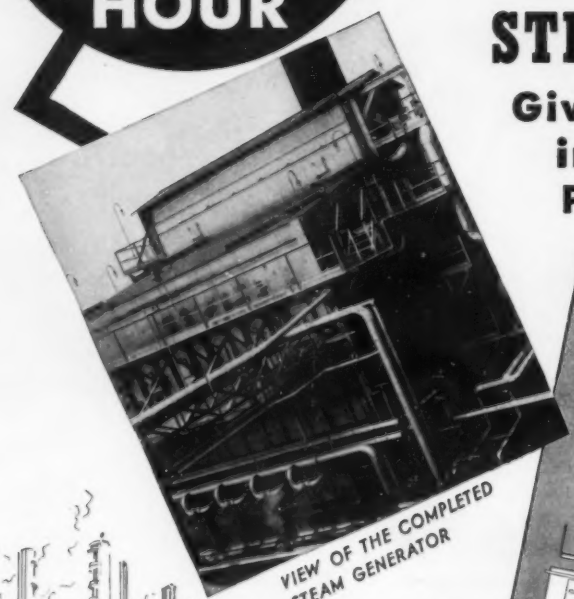
REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

THIS 400,000 Pounds per HOUR

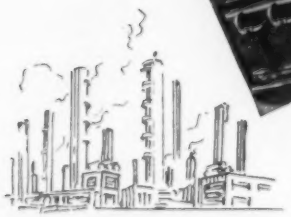
Vogt

STEAM GENERATOR

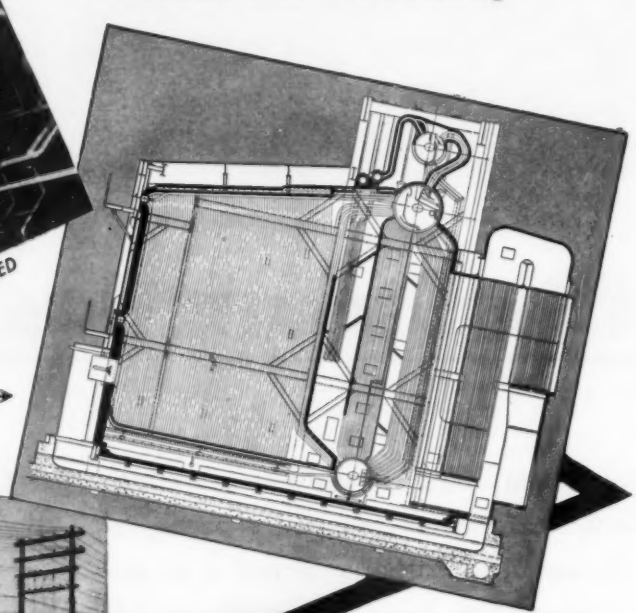
Gives Top Performance in a Leading Texas Petroleum Refinery

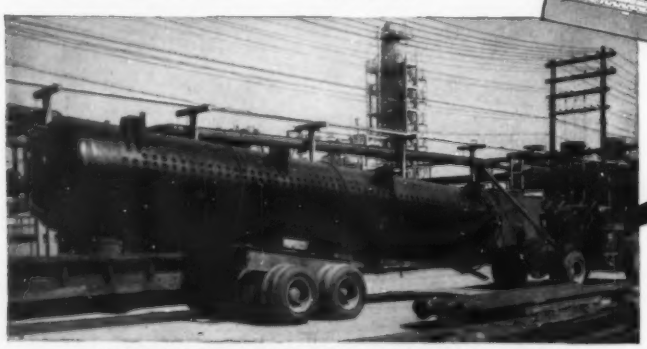


VIEW OF THE COMPLETED STEAM GENERATOR



RIGHT → LONGITUDINAL SECTION THROUGH THE UNIT.





6'-6" DIAMETER x 37'-0" LONG STEAM DRUM BEING TRANSPORTED TO THE ERECTION SITE DURING INSTALLATION.

PRINCIPAL DATA

400,000 pounds per hour capacity.

Fusion welded steam and water drums designed for 700 lbs. S.W.P.

Superheater delivers steam at 750°F. total temperature.

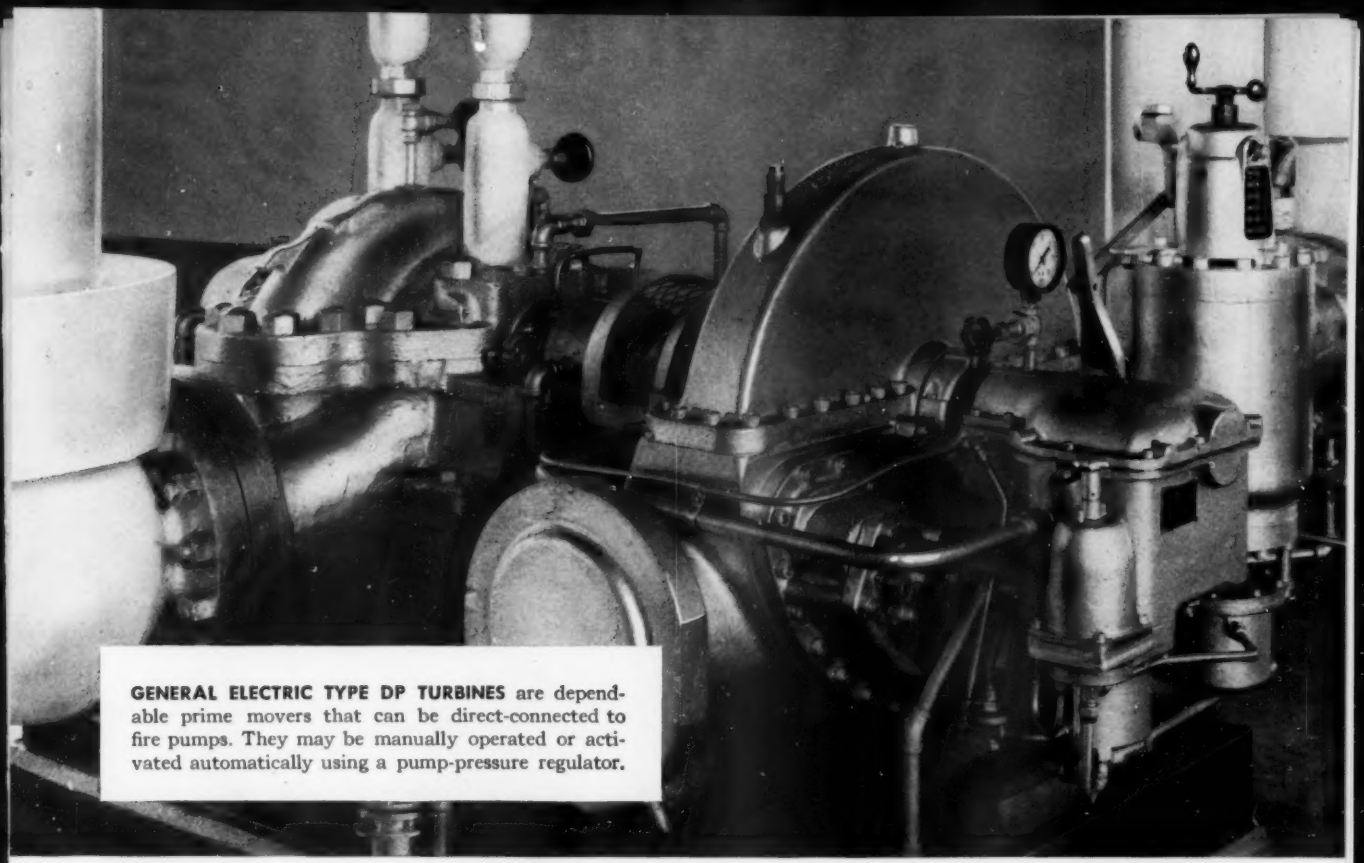
Water cooled furnace.

Burners for Oil and Acid Sludge fuel.

Vogt builds a complete line of bent tube steam generators designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Write for bulletins.

HENRY VOGT MACHINE CO., LOUISVILLE 10, KY.

BRANCH OFFICES: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.



GENERAL ELECTRIC TYPE DP TURBINES are dependable prime movers that can be direct-connected to fire pumps. They may be manually operated or activated automatically using a pump-pressure regulator.

Can Turbine Drives Make Your Plant Fire-protection System More Dependable?

For truly comprehensive plant fire protection, pump drives must be ready for immediate and continuous operation. To help meet these requirements, General Electric Type DP turbines are built to fire-protective code* standards. They have simple, rugged construction, are quick starting, and afford dependable operation.

Available at ratings up to 1200 hp for fire-pump service, these standard Type DP turbines have thousands of hours of proved dependability on regular commercial applications. Features that make them especially reliable for fire-pump drives are:

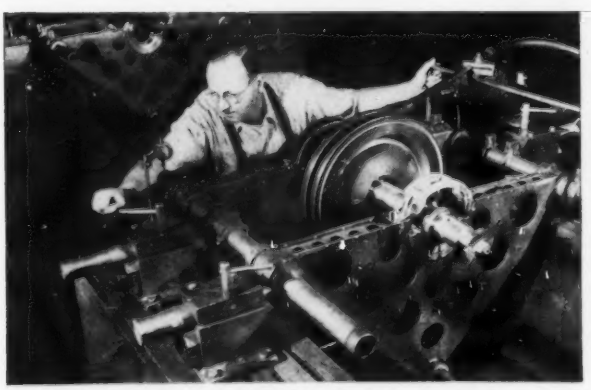
A totally enclosed hydraulic governing system that keeps moving parts to a minimum and eliminates exposed linkage that might wear or corrode.

A compact, pressurized lubrication system that provides more than ample oil, minimizing bearing burnouts during rapid starts, and assuring continuous operation even under adverse conditions.

A sturdy, well-balanced rotor that enables turbines to attain full speed quickly.

Be sure to consider these important features of General Electric turbines for fire-pump drives when planning or reviewing your plant fire-protection system. For additional information, contact the nearest General Electric Apparatus Sales Office or write for GEA-6099, "Mechanical-drive Turbines for Fire Pumps." Address Section 252-67, General Electric Company, Schenectady 5, N. Y.

*National Board of Fire Underwriters' Pamphlet No. 20.



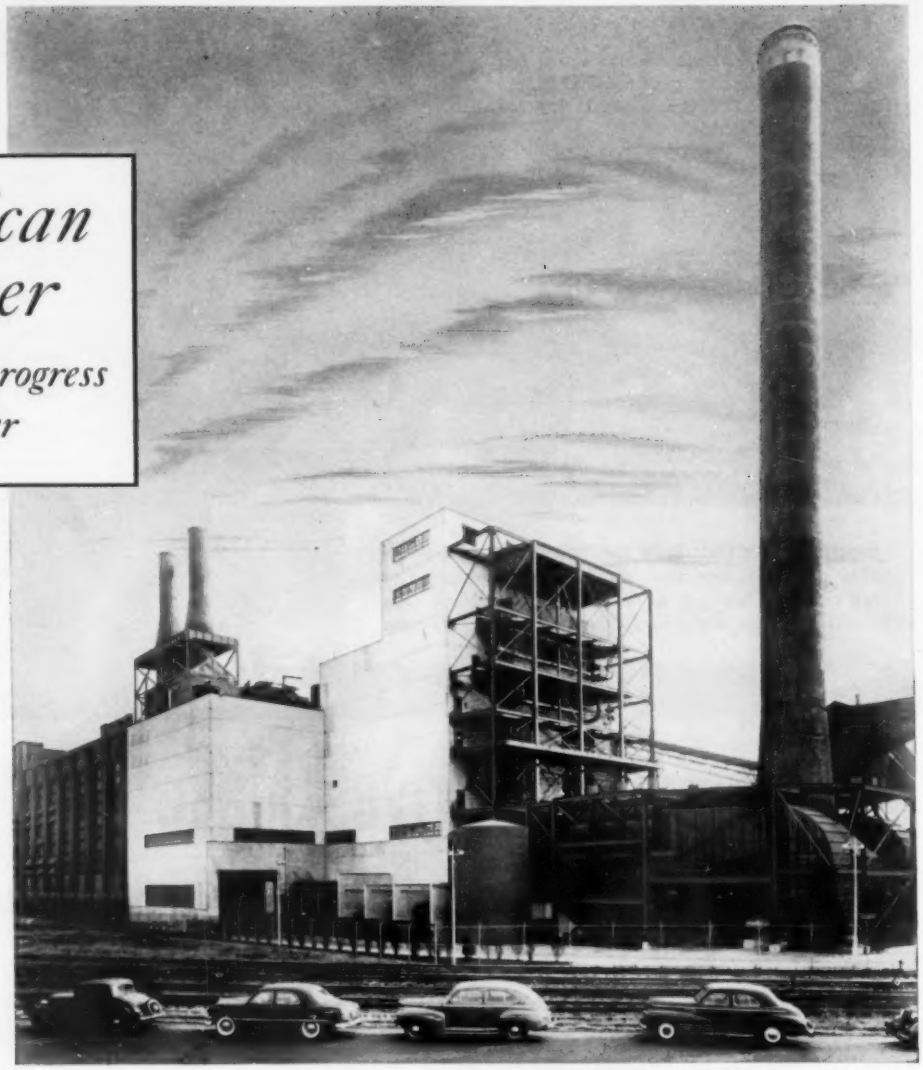
PROPER BALANCE OF TURBINE ROTORS is essential for quick-starting pump applications. Rotors for Type DP turbines are given static and dynamic balancing tests to assure smooth operation throughout the range of turbine speeds.

You can put your confidence in—

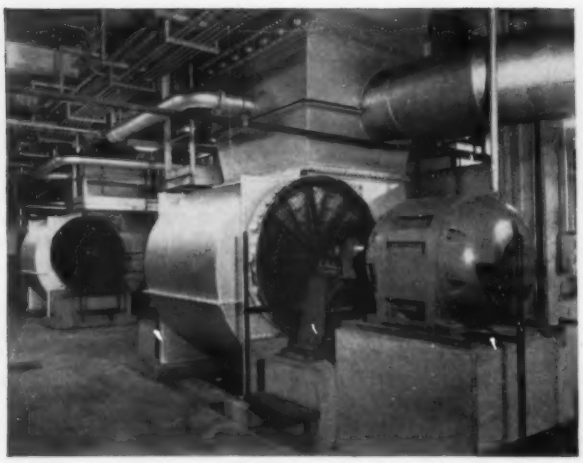
GENERAL ELECTRIC

American Blower

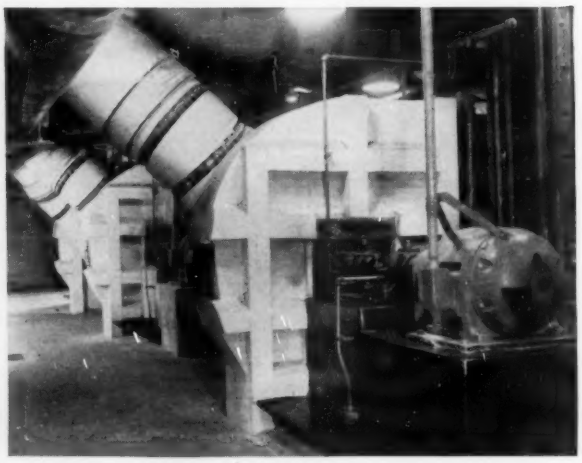
Reports on progress in power



Consolidated of Baltimore's new No. 3 Unit (foreground) at the Gould Street Generating Station has a capacity of 100,000 kw.



Placed in service in December, 1952, the Gould Street Station's No. 3 Unit is served by these two inlet-vane-controlled American Blower Forced Draft Fans.



Three American Blower HS Pulverizer Fans are used in the 75,000 kw. No. 5 Unit at Riverside Generating Station. Total capacity of the plant is 330,000 kw.

Consolidated of Baltimore Triples Generating Capacity in 20 Years

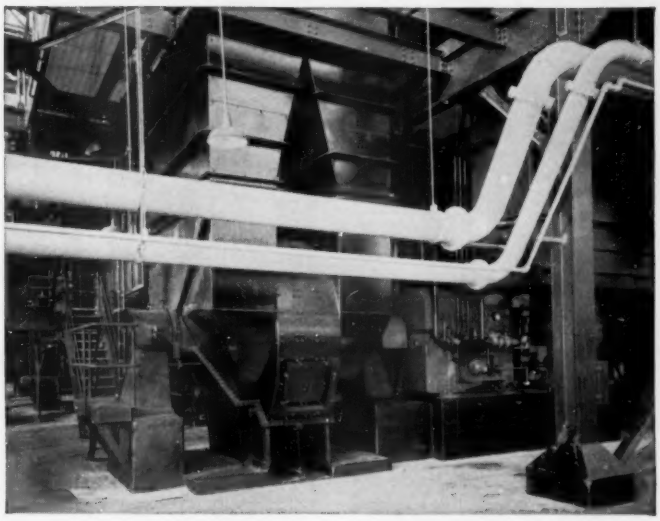
Farsighted program boosts total capacity to 830,500 kw.

Consolidated Gas Electric Light and Power Company of Baltimore serves a 2,283 square mile territory. To meet the rapidly growing needs of its customers, Consolidated of Baltimore must plan for the future — *years ahead.*

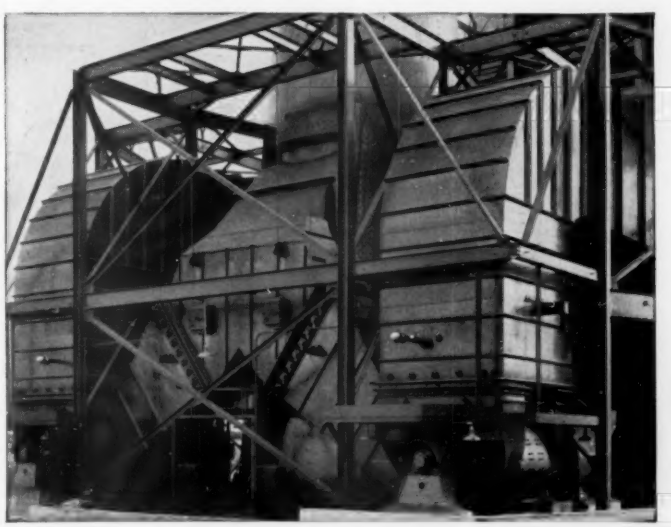
In the past 20 years, electric generating capacity of the company has been increased 3.48 times, from 238,850 kw in 1933 to 830,500 kw in 1953. In addition, completion of the first 125,000 kw unit of the Herbert A. Wagner Station (construction is now under way) will bring total capacity to four times the 1933 figure.

Like many other progressive, investor-owned utilities, Consolidated Gas Electric Light and Power Company of Baltimore has found it pays to use American Blower products.

If you are planning to modernize or expand your facilities, consult your nearest American Blower Branch Office, or write us direct for full information on Mechanical Draft Fans, Heavy-Duty Steam Coils, Dust Collecting Equipment and Gýrol Fluid Drives for boiler feed pumps and fan control.



Gýrol Fluid Drives are used for smooth adjustable speed control of both American Blower Induced Draft Fans (one shown here) at Riverside Station's No. 5 Generating Unit.

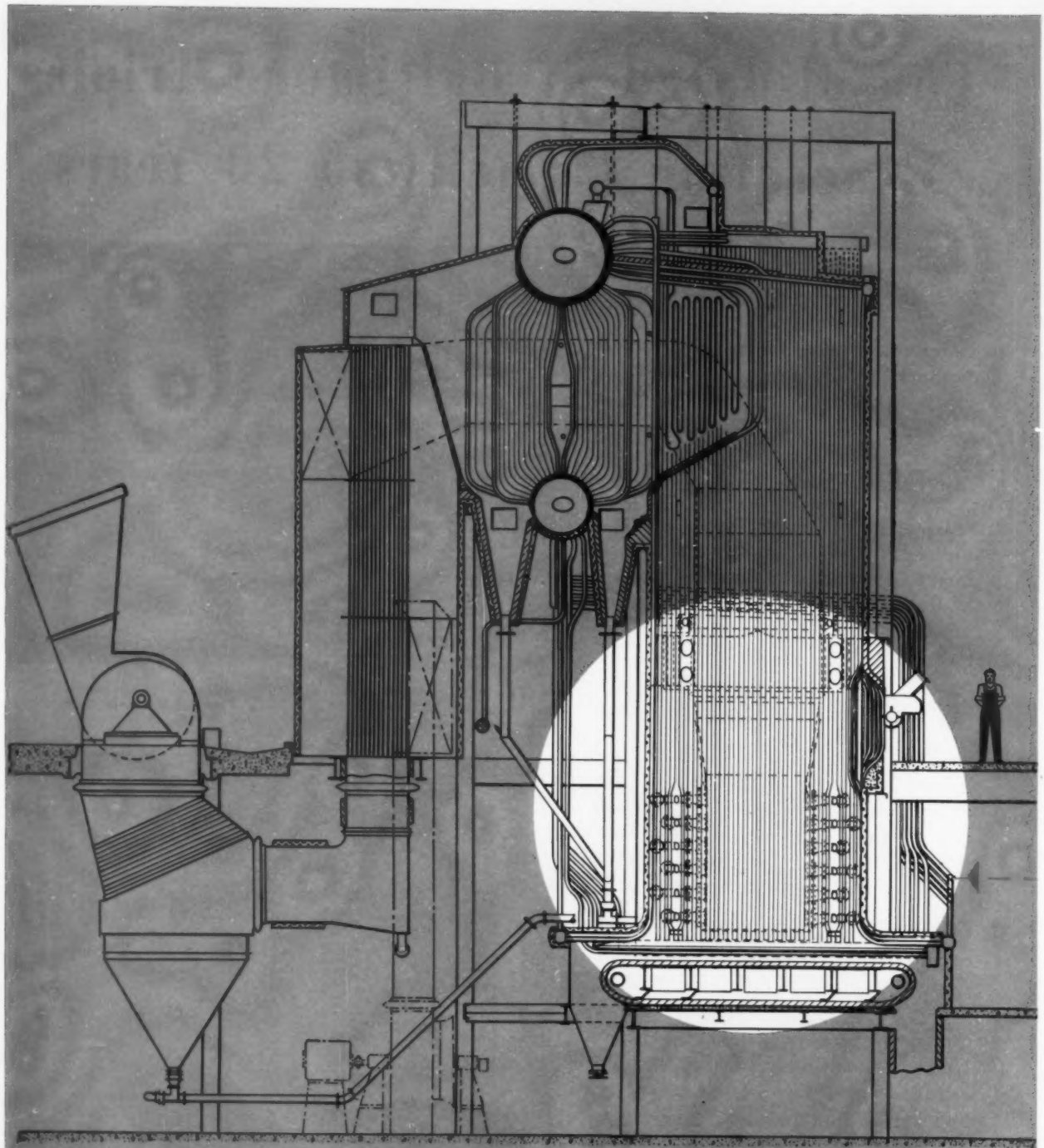


Two American Blower Induced Draft Fans are installed in the No. 3 Steam Generating Unit at the Gould Street Station. Units 1 and 2 also use American Blower Induced and Forced Draft Fans.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS



The C-E Bark-Burning Unit shown above is designed to produce 125,000 pounds of steam per hour at 875 psi and 825 F when fired with bark, and is arranged for the use of oil or gas as alternate fuels.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS, AUTOMATIC WATER HEATERS; SOIL PIPE

NOW BARK HAS LOST ITS BITE

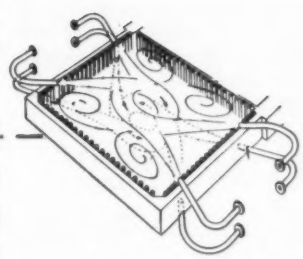
There is no doubt about it — the disposal of bark has always posed a serious problem, particularly to the paper pulp and lumber industries. Bulky, dirty, and moisture-laden, this ever-present waste material accumulates in veritable mountains at many mills and has generally been regarded as a headache.

Sure — it can be burned and — until recently — has been, in cumbersome dutch oven furnaces with much difficulty and inefficiency.

Now — with the availability of the C-E Bark-Burning Unit — "bark has lost its bite." The secret is turbulent, suspension burning as illustrated on the opposite page and described below.

This eminently successful unit is but another in a growing list of C-E developments which have solved difficult problems in the field of fuel burning and steam generation. Outstanding improvements in the methods of burning bagasse, furfural residue, black liquor and lignite, as well as the easy disposal of sewage and industrial wastes — to mention but a few — have not only proved practical but highly profitable.

So if you burn bark, waste wood or other cellulose fuel, investigate the exceptional advantages of the C-E Bark-Burning Unit. Operating installations in various parts of the country are demonstrating its exceptional reliability and efficiency day after day, month in and month out. The experience and engineering competence of the C-E staff are freely available to you and your consultants.



HERE'S HOW IT WORKS...

Bark, wood waste, or other cellulose fuel is introduced into the furnace by special spreader units located considerably above grate level. At the same time, extreme turbulence is produced in the furnace by blowing tangentially directed streams of preheated air through rows of nozzles at various furnace levels as shown in the sketch above. On each alternate level the tangential action is in the opposite direction.

Thus the fuel is fed into a zone of violently swirling air, preheated to a temperature of several hundred degrees. Under these circumstances, moisture evaporates almost instantly — and nearly all of the flash-dried fuel burns in suspension. The remainder falls to the grate in an even layer, where it is quickly consumed.

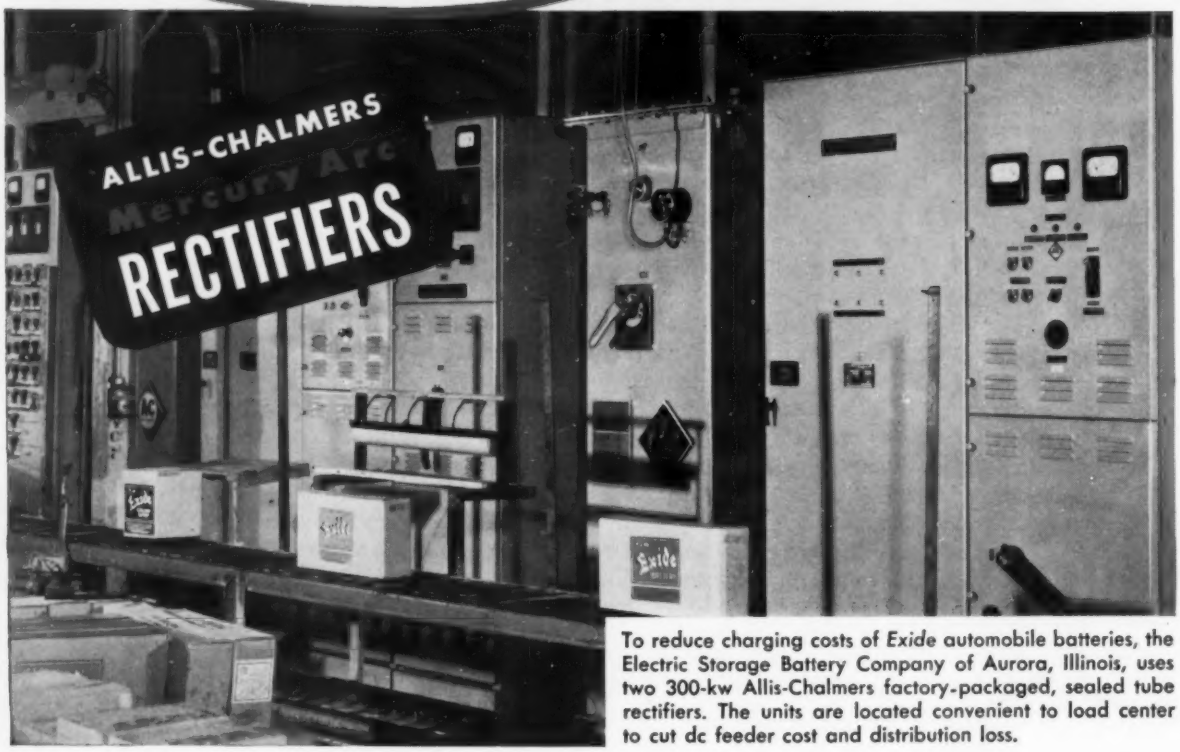
Both Eastern and Western waste woods are being burned with complete satisfaction by this Combustion equipment, and at substantial savings over any previous method.

B-747

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

Low Cost *Installation*



To reduce charging costs of *Exide* automobile batteries, the Electric Storage Battery Company of Aurora, Illinois, uses two 300-kw Allis-Chalmers factory-packaged, sealed tube rectifiers. The units are located convenient to load center to cut dc feeder cost and distribution loss.

FACTORY-PACKAGED RECTIFIER UNITS CUT INSTALLATION TIME AND COSTS

The factory-packaged design of Allis-Chalmers sealed tube mercury arc rectifiers has all component parts metal enclosed and integrally connected in one compact unit to cut labor time and costs . . . only connection to power and control leads and to cooling water supply is necessary to make unit ready for service. Because of their light weight, the rectifiers can be installed on a balcony or elsewhere, close to load centers to minimize direct-current feeder cost and reduce distribution loss . . . requires no special foundation.

Allis-Chalmers sealed tube rectifiers are offered in ratings from 220 kw at 250 volts to 1000 kw at 600 volts.

When you are planning new direct-current power installations of *any* size, compare the many cost cutting features of Allis-Chalmers mercury arc rectifiers. For complete details and engineering help, call your nearest A-C sales office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4303

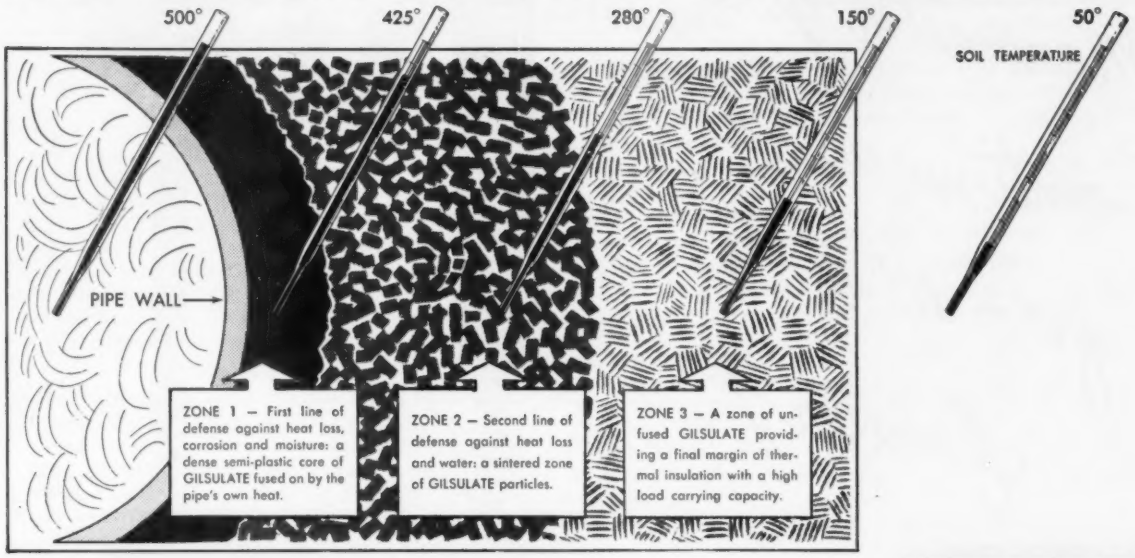
ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Our Engineers Introduced Mercury Arc Rectifiers to U. S. Industry

Lowest Cost

PER INSTALLED LINEAR FOOT OF ANY HOT UNDERGROUND PIPE INSULATION


500°
425°
280°
150°
50°
SOIL TEMPERATURE
PIPE WALL
ZONE 1 — First line of defense against heat loss, corrosion and moisture: a dense semi-plastic core of GILSULATE fused on by the pipe's own heat.
ZONE 2 — Second line of defense against heat loss and water: a sintered zone of GILSULATE particles.
ZONE 3 — A zone of unfused GILSULATE providing a final margin of thermal insulation with a high load carrying capacity.

GILSULATE®...the triple-zone insulation that fuses itself into lifetime protection for hot underground pipes. Water-proof, corrosion-proof, root-proof, acid/alkali-proof.

Compare your present insulation methods with Gilsulation:

1. Pour Gilsulate granules out of the bag onto the pipe; tamp it down.
2. Backfill: *the job is insulated!*

Gilsulate—nature's own insulation—is a unique, solidified hydrocarbon that virtually installs itself. Normal pipe-heat (up to 520°F) does the rest—fuses the Gilsulate to the pipe in hours, forming a massive circular solidified sheath.

Gilsulate costs less installed per linear foot *than any other underground pipe insulation*... it's easiest to use... and has been tested in scores of the country's largest and most important installations.

Some additional Gilsulate advantages:

- *3 grades available*—220° to 520° F
- *needs no sleeves* or mechanical sheaths
- *requires no mixing* or special handling
- *can't be punctured* — leave rocks in backfill
- *pipe expands and contracts* within Gilsulate structure
- *proved in actual use* in hundreds of new construction and replacement installations

Send coupon for descriptive literature.

AMERICAN GILSONITE COMPANY
SALT LAKE CITY, UTAH
Affiliate of Barber Oil Corp. & Standard Oil Co. of California

No skills necessary—simply pout Gilsulate out of 100 pound bags, tamp and backfill. Can be used under any and all conditions—no matter how many pipes, whatever the space.

GILSULATE®

THE TRIPLE-ZONE INSULATION
FOR LIFETIME PROTECTION
OF HOT UNDERGROUND PIPES.

American Gilsonite Company
134 Wes. Broadway, Salt Lake City 1, Utah
or 1145 East Jersey Street, Elizabeth 4, N. J.

Please send me descriptive literature on Gilsulate.

NAME.....

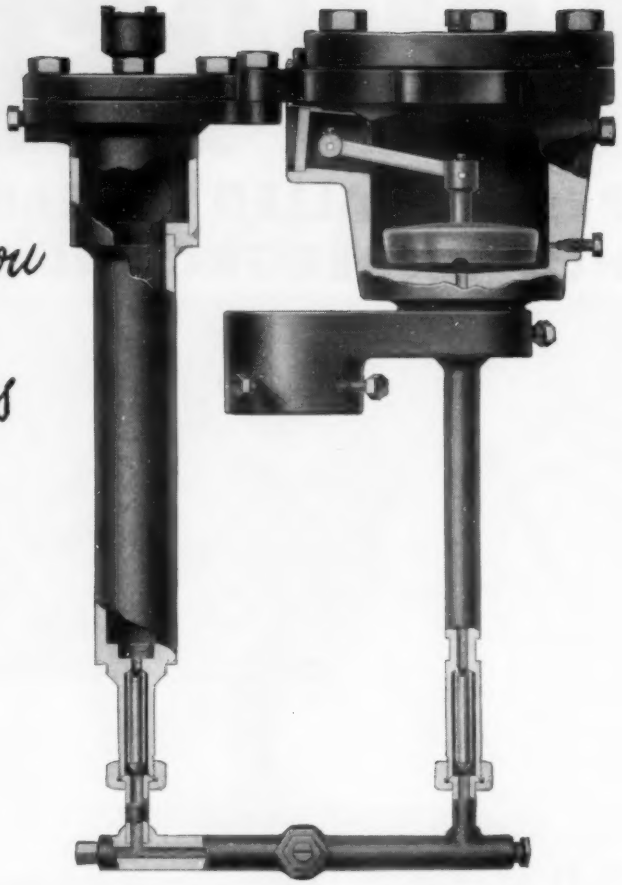
TITLE.....

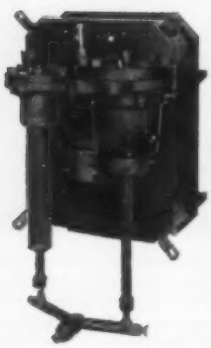
COMPANY.....

ADDRESS.....

P

Taylor Mercury Manometer gives you continuous ranges from 10" to 533" of water!





AND no piping changes are necessary when changing from one range to another, because there are six interchangeable range tubes (10″, 20″, 50″, 100″, 200″ and 400″ of water). All except 10″ range may be over or under-ranged 33⅓%. Instrument has pressure connections both at side and top of manometer; a union coupling prevents distortion of bearing housing . . . eliminates binding or friction caused by wrench torque; when necessary for recording two Flows or for Ratio-Flow control two manometers can be mounted on the back of a single case.

NOTE THESE ADDITIONAL FEATURES:

Great power—thanks to extra big float with extra long travel. Microfinished shaft with Teflon bearings "float" this power right through to the pen.

High accuracy—inherent straight line calibration.

Positive actuation—high energy output. Big 3 5/16″ float. Long float travel—1″. Simple lever system. Teflon in pressure-tight bearing surfaces for efficient use of power. Jewelled thrust bearing.

Dependable performance—submerged check valves give positive shut-off. Unique damping valve adjustable under full pressure without leakage. Ample room in mercury chambers to accommodate surges or pulsating flows. Teflon holds pressure, yet lets shaft turn freely, giving long service.

Ease of maintenance—low pressure chamber cover permits easy access to float and lever arm during calibration. Entire pressure tight bearing easily and economically replaced.

Ask your Taylor Field Engineer, or write for **Bulletin 98182.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

(Advertisement)

BRIDGEPORT BRASS COMPANY

CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Improved Corrosion Resistance of Condenser Tubes by Correct Alloying

Large-scale research into condenser tube alloys was launched in 1896, the year Bridgeport Brass began manufacturing the first Admiralty Condenser Tubes. Since that time, literally hundreds of metal combinations have been developed to meet a variety of corrosive conditions in modern power, processing and refining plants. Let's look briefly at the basic alloys.

The Brasses

Early condenser tubes standardized on brass of 70% copper and 30% zinc. Adding 1% tin to this mixture produced Admiralty alloy which checked to some extent the chief drawback of the original mixture, dezincification in fresh and salt waters. Later experiments showed that other elements added in small amounts to 70-30 brass had more or less the same effect. Those elements include arsenic, antimony, phosphorus, nickel, tungsten and aluminum.

Among the inhibitors, arsenic proved by far the most powerful. Additions of 0.027% arsenic to Admiralty and 0.21% arsenic to Muntz Metal (60% Cu, 40% Zn) cut dezincification by 66% and 80% respectively. Dezincification decreases also as copper content increases, reaching a low point in salt and fresh water with Red Brass (85% Cu, 15% Zn).

The low-copper brasses, on the other hand, are highly resistant to corrosive sulfide-bearing solutions and vapors encountered in petroleum refining and processing. Admiralty and Muntz Metal may corrode at 1/10th or less the rate of Copper or Red Brass.

The addition of aluminum to copper-zinc alloys markedly increases resistance to impingement corrosion of rapidly flowing or turbulent water. Dezincification in these alloys can be substantially reduced by the use of arsenic as an inhibitor.

Cupro Nickel Alloys

The most common copper-nickel alloy is 70% copper – 30% nickel. Widely used in marine condensers, 70-30 Cupro Nickel stands up well under fast-flowing sea water. When about ½% of iron is added to this mixture, resistance to impingement corrosion is considerably improved.

This alloy finds its chief application, however, in the handling of sodium hydroxide and other alkaline solutions, being the most resistant of the copper-base alloys to their corrosive action. In sulfide-bearing solutions, 70-30 Cupro Nickel has approximately the same corrosion resistance as Admiralty and Muntz Metal.

Other mixtures of Copper-Nickel (80-20 and 90-10), with higher additions of iron, can often replace the 70-30 alloy when nickel is in short supply.

The Bronzes

The most important of the bronzes used in condenser tubes is Arsenical Aluminum Bronze (Duronze IV), composed of about 95% copper and 5% aluminum plus arsenic. It is notably superior for fresh and brackish water corrosion and brines with low concentration of sulfides, but not recommended for ammonia-contaminated fluids.

Combinations of copper, tin and small amounts of phosphorus (to 0.35%) show good immunity to flowing sea waters and most acids, except hydrochloric.

Copper-Silicon alloys rank with plain copper in corrosion resistance, and are chosen over copper chiefly for mechanical properties and weldability.

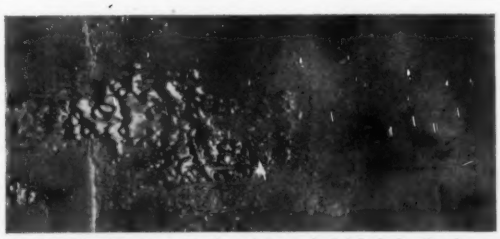
Duplex Tubes

Many applications of condensers and heat exchangers are troublesome because the tube is attacked simultaneously inside and out by entirely different types of corrosive media and few single metals can withstand these double attacks. The answer is found in Duplex Tube, a tube of one metal which encases another tube of a different metal, each picked to meet one particular corrosive condition. Combinations of metals in Duplex run into the hundreds – Admiralty, Muntz Metal, Cupro Nickel, Aluminum Brass, etc., coupled with steel, nickel, aluminum, Monel, lead, plus many others.

Continuing Research

These alloys and many others developed to meet a variety of applications are the result of our continuous research program. Bridgeport Technical Service, with its experienced engineers and fully equipped laboratories, is ready to help solve your condenser tube problems. Call any one of the Bridgeport Sales Offices, located in principal cities to take advantage of this service. Stocks of Bridgeport condenser and heat exchanger tubes are carried in Beaumont, Texas; Ponca City, Okla.; Los Angeles and San Francisco, Calif., for your urgent needs.

(1790)



Results of impingement attack on inlet end of Admiralty Condenser Tube, (cut open, flattened and magnified 1½X).

A section of Bridgeport Aluminum Brass Tube, (magnified 1½X), in the same service, showing absence of impingement corrosion.

Sure Cure

FOR PROFIT-DRAINING PRODUCTION SHUT-DOWNS

NEW 800 HANCOCK STEEL GATE VALVE TYPE 950

Bolted Bonnet

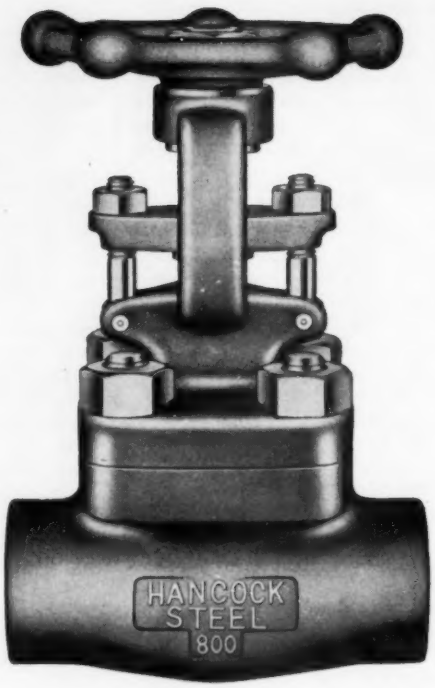
Outside Screw and Yoke
Sizes: 1/4" through 1"

This new 800# Hancock Bolted Bonnet Steel Gate Valve is typical of the outstanding quality which has always made Hancock Valves the best buy in terms of long, efficient, trouble-free performance. It more than meets the exacting requirements of process and power piping systems in refineries, petrochemical, power and industrial plants. Built into this new Type 950 are design and operational features proved in the toughest services. Here are construction elements you get in this new Hancock 800# Bolted Bonnet Steel Gate Valve:

1. **Spiral wound stainless steel gasket.**
2. **"500 Brinell" stainless steel wedge.**
3. **11-13% chrome stainless steel seats.**
4. **Stainless steel swing bolts and nuts.**
5. **Highly accurate guiding to prevent wedge dragging on seating surfaces and consequent leakage.**
6. **Positive back seating.**
7. **Corrosion-inhibiting packing that assures complete freedom from stem pitting.**
8. **Repacking ease.**
9. **Safe, comfortable handwheel built to operator's specifications.**
10. **Corrosion-resistant exterior finish.**

Be sure of complete dependability and long-life economy. Reduce maintenance and inventory costs. Install Hancock 800# *Bolted Bonnet* Steel Gate Valves. Remember, they cost no more than ordinary valves, yet do a job and stay on the job.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR knows the *economy of quality* that's built into all Hancock Valves. You can depend on him for practical counsel as well as prompt delivery from local stocks.



Service Ratings

Screwed and Socket Weld Ends: For all pressures up to 800 psi at 775°F. — O.W.G. 2000 psi, 100°F.

Flanged Ends: For all pressures up to 800 psi at 775°F. — O.W.G. 1440 psi, 100°F.

Alternate Trims include:
Cobalt-Chromium-Tungsten Alloy, Hard Facing.
18-8% Stainless or 20% Nickel, 8% Chrome.
Monel.
Hastelloy.

When Hancocks go in, valve costs go down

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

G-E Motors Are Custom-built for Power Station Service!

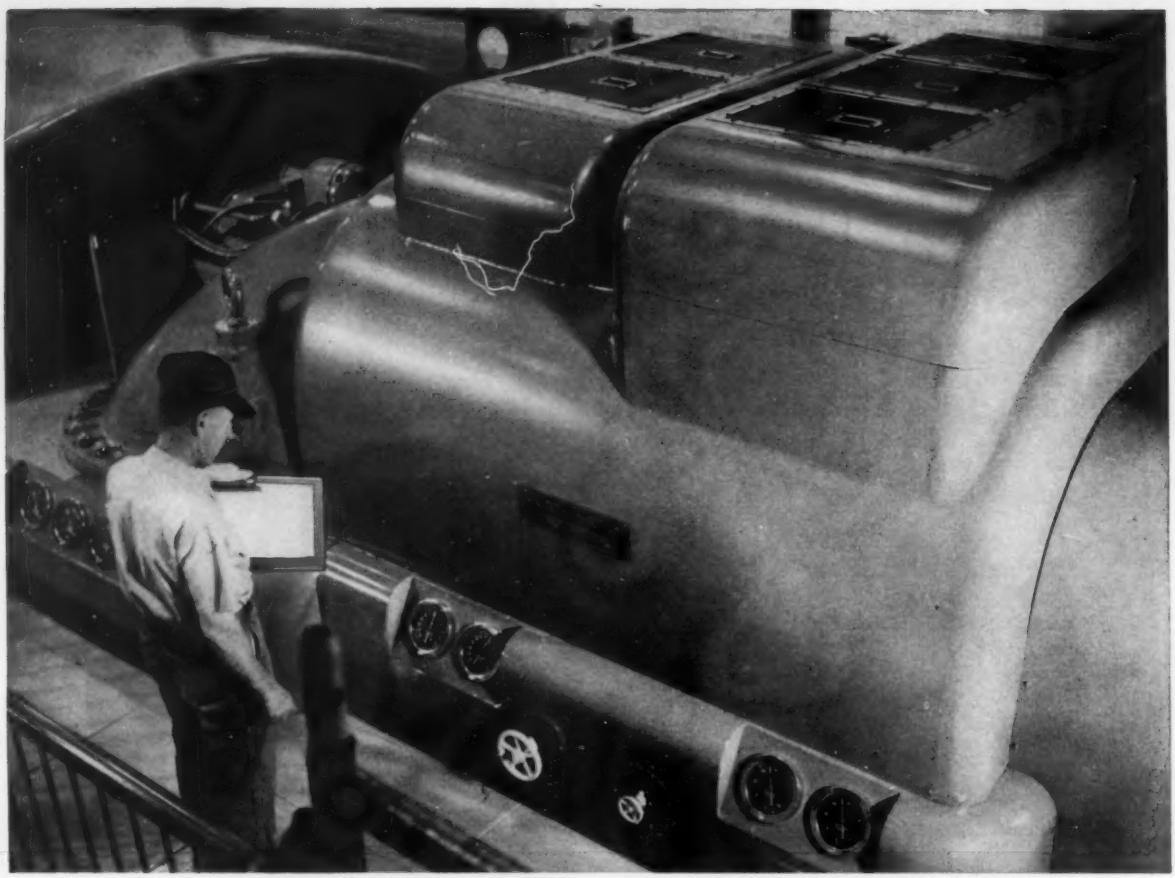
OUTDOORS OR IN, General Electric power station motors are built to give you dependable, economical service. For example, the two vertical Tri-Clad* totally enclosed fan-cooled motors, shown here, have given consistent reliable performance under all weather conditions at the A. B. Paterson Steam-Electric Generator Station of New Orleans Public Service Inc.

GENERAL ELECTRIC'S 70 YEARS of experience in designing, building, and servicing motors for power station requirements assures you of getting the right motor for the job. Whatever your needs in power station motors, G.E. can furnish a complete line including dripproof, totally enclosed fan-cooled, totally enclosed air-water cooled, and weather protected motors in both horizontal and vertical construction.

FOR MORE DETAILED information on G.E.'s power station motors, contact your nearest G-E Apparatus Sales Office. *General Electric Co., Schenectady 5, New York.* 830-1

*Registered Trade-mark of the General Electric Company

GENERAL ELECTRIC



MODERN DESIGN IN TURBINE-GENERATORS. This streamlined Worthington turbine-generator unit at the University of North Carolina is capable of developing 2500 kw over and above the 10,000 kw normally produced. In addition, sufficient steam is automatically extracted to heat the University buildings.

Look how turbine-generators have changed!

Remember the bulky, complicated turbine-generators of only a few years ago?

Compare them with this sleek, powerful Worthington 10,000-kw unit installed at the University of North Carolina last year. Everything about this turbine-generator is modern and up-to-date.

Look at the streamlined heavy steel lagging which covers the turbine, generators and exciter. Note the recessed dials, set at a thirty degree angle so they may be read from standing height with ease. And the dials don't project into the room, where they might be damaged.

In addition to getting the most modern unit of its kind, the University of North Carolina benefitted by the undivided responsibility that goes with every Worthington turbine-generator. Each is designed, assembled, and tested as a complete unit *before* shipment.

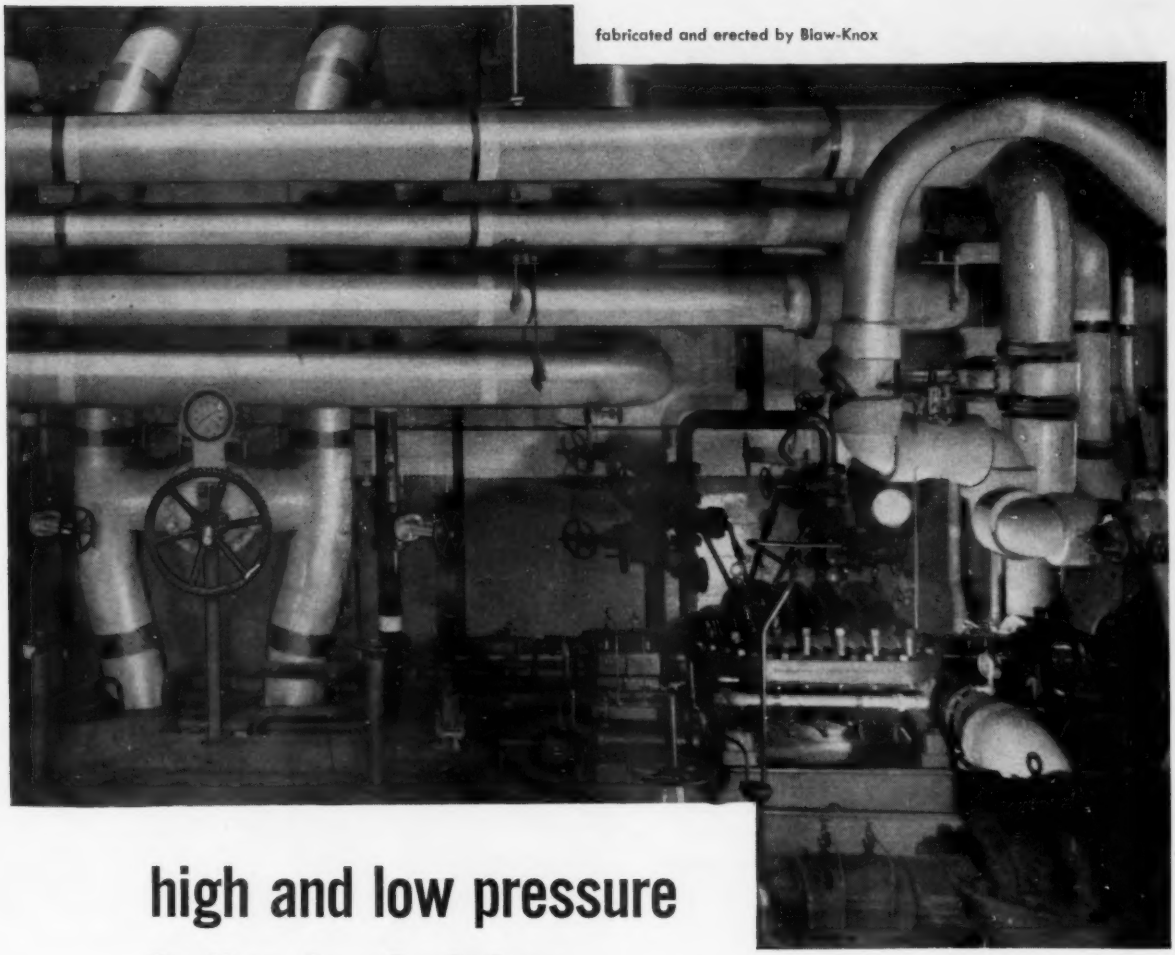
Find out how Worthington turbine-generator sets pay off in longer, more economical power generation service. Sizes range up to 11,500 kw. Get in touch with your nearest Worthington district office for more information. Or write to Worthington Corporation, Steam Turbine Division, Section T.4.2, Wellsville, New York. T.4.2

WORTHINGTON

STEAM TURBINES

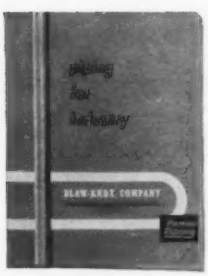
Single- and Multi-Stage Turbines • Turbine-Generators • Deaerators • Boiler Feed Pumps • Surface Condensers

A GREAT TEAM IN STEAM



fabricated and erected by Blaw-Knox

high and low pressure boiler feed piping . . . in large steel mill



To get more information on piping for industry write for your copy of Bulletin No. 2443.

When you need a piping system similar to this one . . . or a system for any pressure and any temperature requirements . . . you can readily obtain the benefit of our long experience in this field. We'll take the job from original engineering to final erection. Always in close cooperation, of course, with your consultants or your own organization.

This complete service includes modern shop facilities for hot and cold bending, welding and fabricating all types of piping. A metallurgical research laboratory which assures you of the latest developments in high pressure, high temperature piping. Newest types of testing equipment to assure the soundness and strength of the piping.

And a complete service force equipped with modern machinery for field erection . . . plus the necessary manpower to handle jobs of any size.

How much service do you want?

We can readily (1) engineer, fabricate and erect your job . . . or (2) simply fabricate and erect . . . or (3) fabricate only.

Our engineers will quote from your drawings . . . or, when desired, make a field study of your piping requirements before quoting.

Let us know your service requirements . . . and we'll provide what you need.

BLAW-KNOX COMPANY
Power Piping and Sprinkler Division
Pittsburgh 33, Pennsylvania

BLAW-KNOX

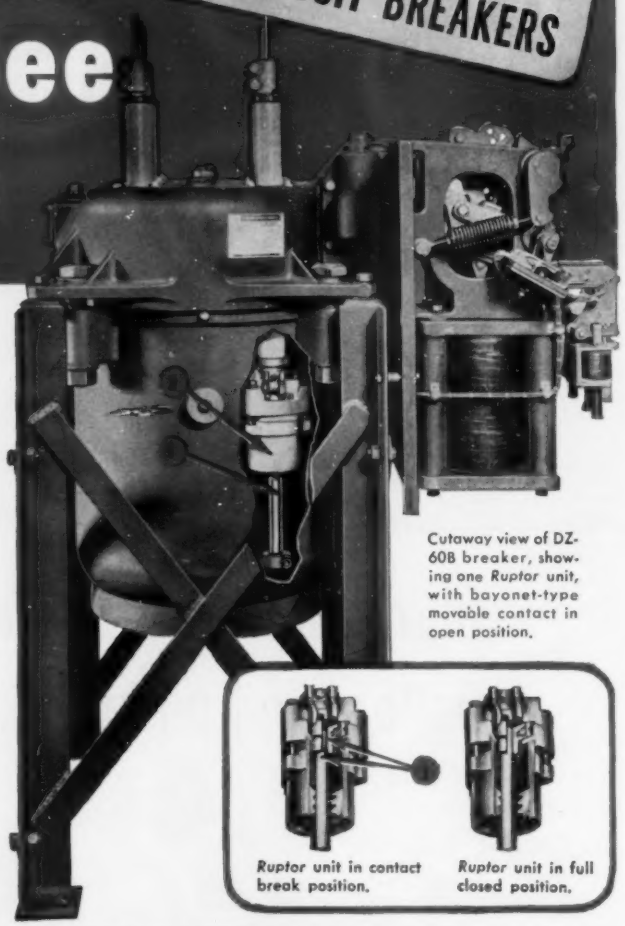
POWER PIPING

Complete prefabricated power piping systems for all pressures and temperatures . . . plus complete line of functional spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators

Three Reasons Why

...Years of Trouble-Free Service

ALLIS-CHALMERS *Indoor* **OIL CIRCUIT BREAKERS**



Cutaway view of DZ-608 breaker, showing one *Ruptor* unit, with bayonet-type movable contact in open position.

Ruptor unit in contact break position.

Ruptor unit in full closed position.

One **Few moving parts!**

Bayonet contacts (1) are the only moving parts of the *Ruptor* interrupting device.

Two **Easy inspection!**

Drop the tank, and the bayonet contacts are visible in open position. For access to the stationary contacts, one needs only to remove four bolts and cylindrical shell (2).

Three **Self-aligning and Self-cleaning contacts!**

Tulip and bayonet contacts (3) maintain high conductivity without readjustment or cleaning. Arc energy is minimized by efficient interruption within oil-filled *Ruptor* unit. This in turn contributes to long contact life and low oil deterioration.

In addition, a mechanically trip-free solenoid operating mechanism controls contacts of time-proved *Ruptor* interrupting devices And pole unit mechanism is self-lubricated — completely enclosed — sealed from dust, dirt, corrosion.

In brief, Allis-Chalmers DZ breakers are built to assure years of dependable, trouble-free service.

Allis-Chalmers power circuit breakers are available in ratings from 2.5 to 230 kv, with interrupting capacities from 15,000 to 10,000,000 kva, to meet all industrial and power company requirements. For more information, call your nearby A-C representative, or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4057

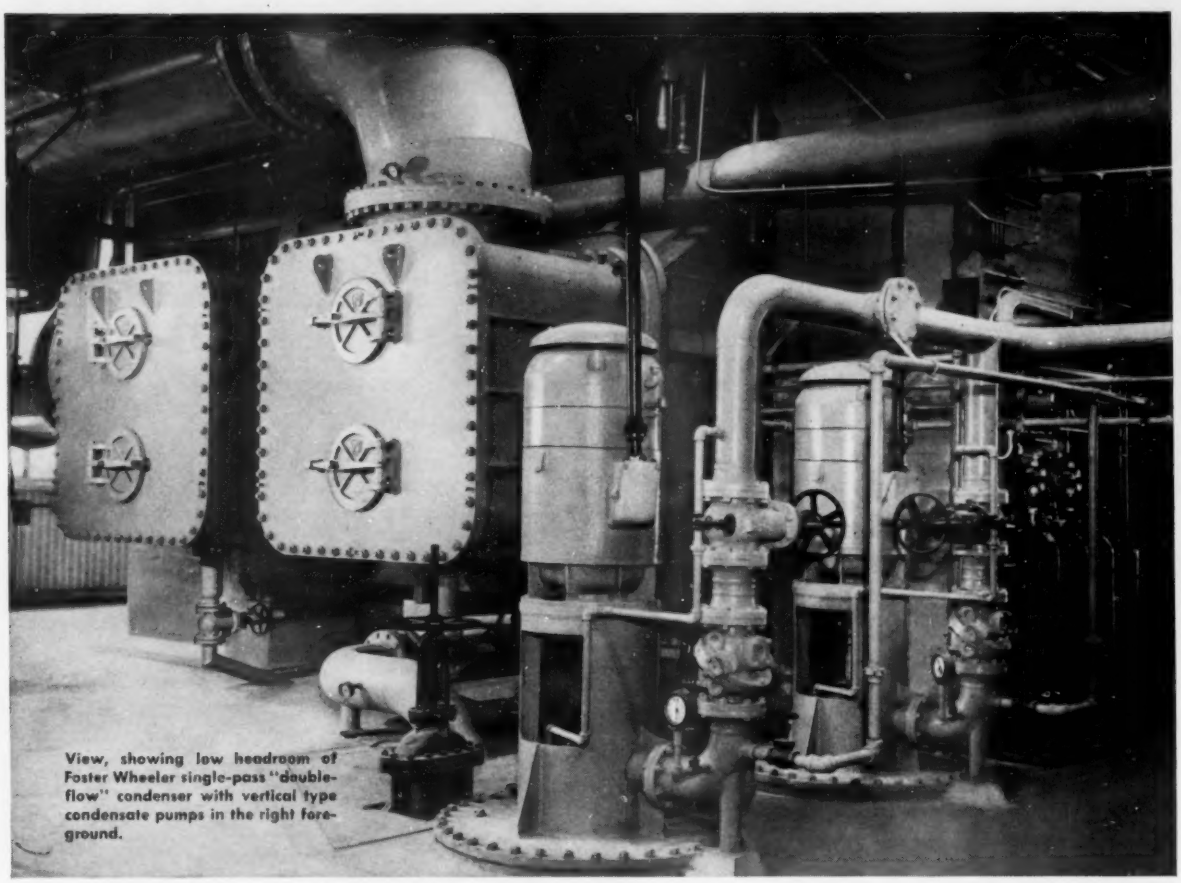
Ruptor is an Allis-Chalmers trademark.

TYPE	RATED KV	MINIMUM KV AT RATED KVA	RATED AMPS	KVA INT. CAPACITY
DZ-408*	7.2	2.3	600	100,000
			1200	100,000
			2000	100,000
DZ-608†	13.8	4.0	600	150,000
			1200	150,000
DZ-1008†	13.8	4.0	1200	250,000
DZ-2008†	13.8	6.6	1200	500,000
			2000	500,000

*Ask for Bulletin 71B6179. †Ask for Bulletin 71B6129.

ALLIS-CHALMERS

SHORTER on headroom - LONGER on savings



View, showing low headroom of Foster Wheeler single-pass "double-flow" condenser with vertical type condensate pumps in the right foreground.

New Foster Wheeler "double-flow" condenser uses 40% less headroom – cuts building costs – more than meets the highest performance standards

Utilizing a volume only 60% of that customarily required, the new Foster Wheeler "double-flow" principle marks a new advance in condenser design. Less headroom is required—often 40% less than the over-all height of conventional units. This means a proportionately shorter turbine pedestal—and a substantial reduction in building costs.

The rectangular shape makes possible complete utilization of the space available. Intimate contact and scrubbing action between steam and condensate promote effective deaeration and reheating. Condensate leaves the hotwell at steam temperature under all operating conditions. Also, because of the larger steam entrance and shorter tube-bank depth, pressure loss is reduced to a minimum. Efficient cooling of the non-condensate vapors and gases is provided by triangular cooler sections of the series zone type.

In a typical test of a 32,500 sq. ft. unit, the actual heat transfer coefficient showed 578 Btu per hr. per sq. ft. per F as against 510 for commercially clean tubes,—thus resulting in an absolute pressure 0.10 inch better than expected. Further details on request.

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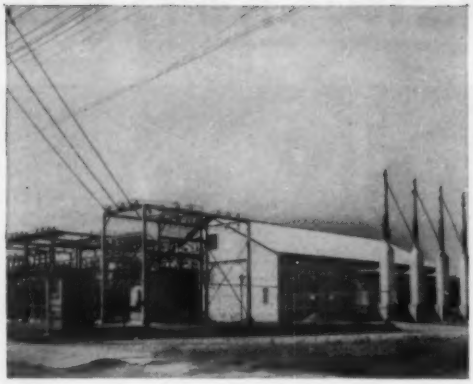

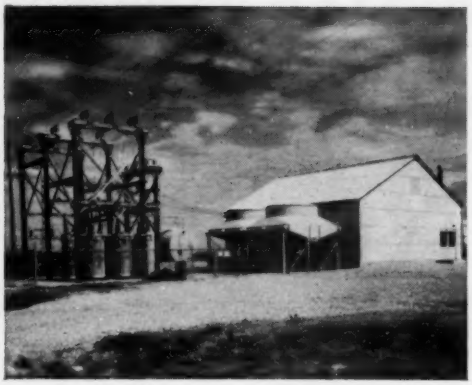

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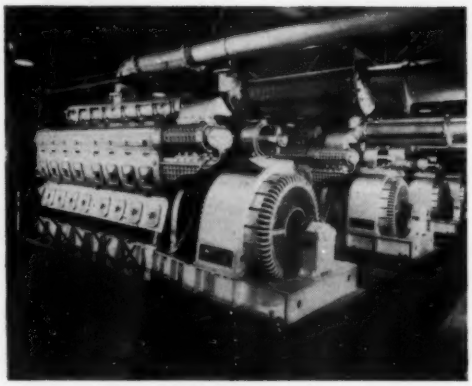

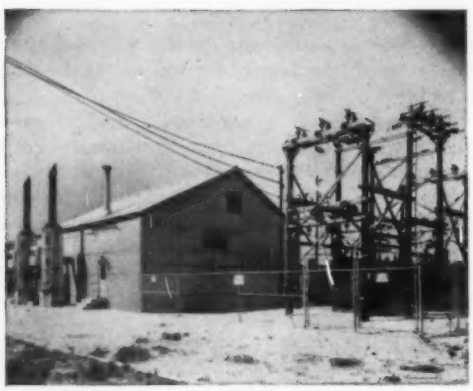

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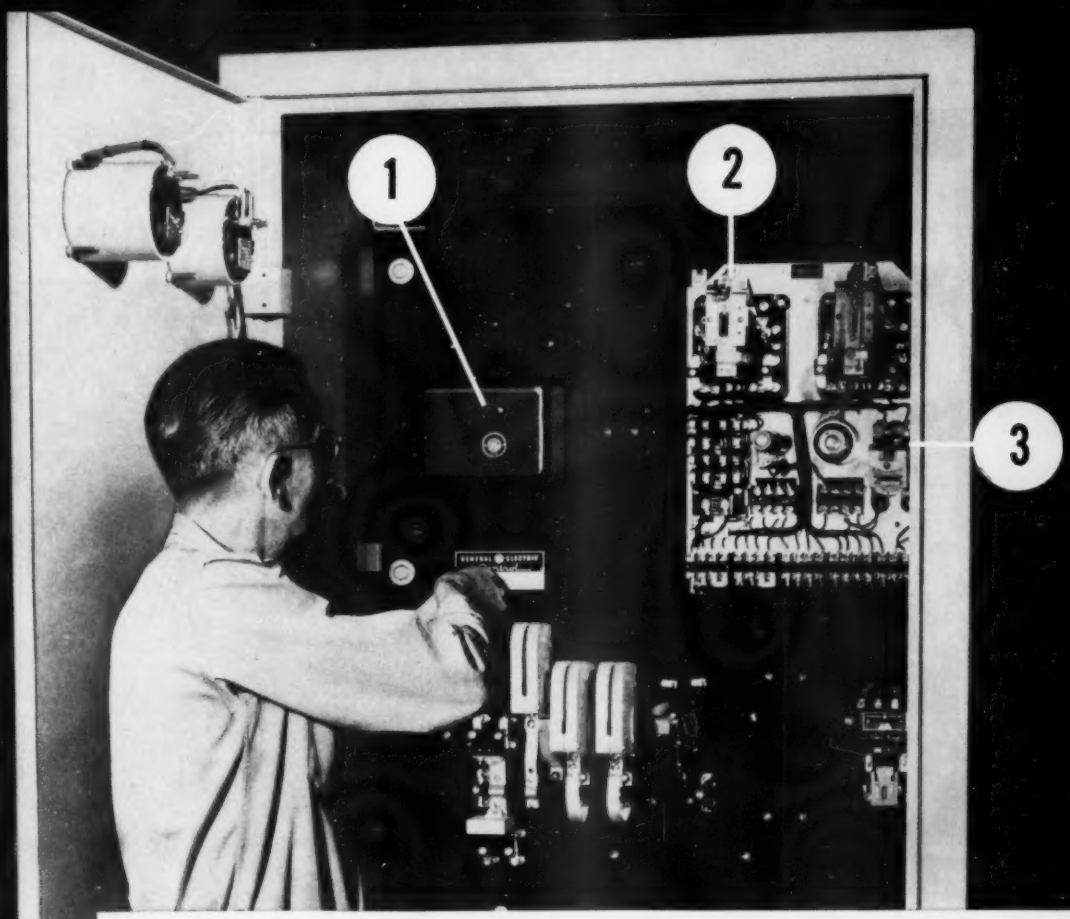

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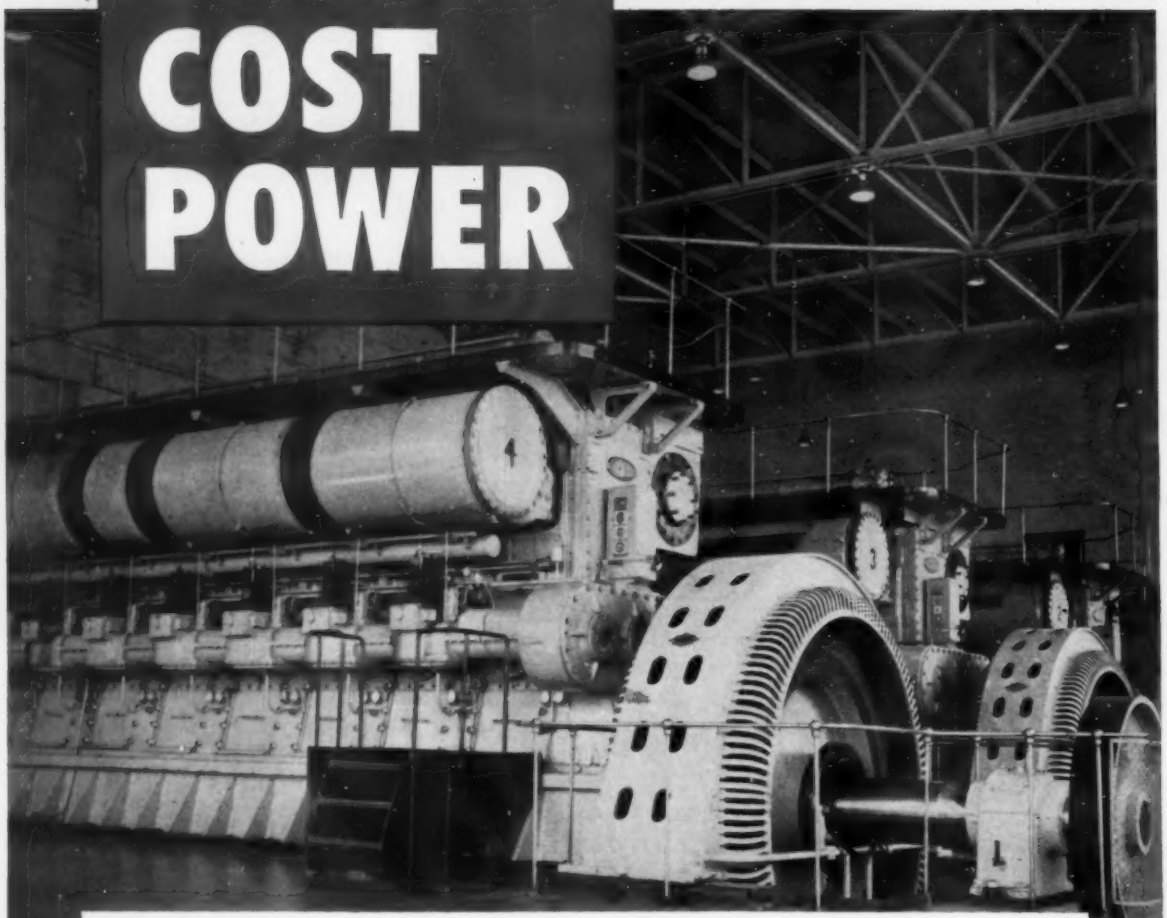

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The *Texaco Ursa Oil* series is a complete line of lubricating oils especially refined to make diesel, gas and dual-fuel engines deliver *more power* with *less fuel* over *longer periods* between overhauls.

Best evidence that Texaco delivers these benefits is this fact—

For over 20 years, more stationary diesel horsepower in the U. S. has been lubricated with Texaco than with any other brand.

A Texaco Lubrication Engineer will gladly help you select the proper oils to give you maximum efficiency at lowest possible cost. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

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Smoke-Chart Debate

MANY COMMENTS, mostly favorable, have come in about "POWER's MicroRingelmann—A New Aid to Smoke Inspectors," published in March. We invite further discussion, particularly from those who may see flaws in our proposal, for our primary aim is to be helpful rather than to promote some "bright idea" of the editors.

Although the negative comments have been few, one seems important and all should have careful consideration. Here are the main objections offered:

1. The Ringelmann is now incorporated in many smoke ordinances. Readings made with a MicroRingelmann or any other secondary standard will not be accepted by the courts as meeting the "letter of the law."
2. No visual tests of any sort should be permitted. They are unreliable. The only acceptable evidence of a smoke violation is a test made on an actual smoke sample at the plant.
3. The Ringelmann is an old and obsolete unit. Changes in brightness of the day and differences in eyes will affect the appearance of smoke. There must be some more scientific way to rate smoke density.

Let's take these objections up in order.

1. *Where the ordinance specifies Ringelmann, no equivalent will stand up in court.* Answer: A very good point. We don't know the answer. Let's see what happens.

2. *No visual tests should be accepted.* Answer: Smoke enforcement would be far more costly and far less effective if the inspector invariably had to make a test at the plant before he could report a violation. The cost angle is obvious. It is also obvious that, where violations were the result of improper *operation* (either deliberate or careless) the persistent offender could escape all penalty merely by playing "good boy" during the period of a test.

Thus the at-the-plant test—of great value in testing the capacity of equipment to operate smokelessly, and for comparing various fuels and operating methods—could not possibly carry the full burden of an effective smoke-prevention program.

3. *Ringelmann is old and obsolete, etc.* Answer: It certainly is old, but can't be called obsolete until something better is available. After careful study we are not convinced that any visual method more accurate than the Ringelmann is available. After all, every visual method must compare the *appearance* of the smoke with the *appearance* of some standard.

The effect of light variations and of differences in eyes is less important than one might imagine. It is true that both greatly affect the appearance of the smoke, *but they also affect the appearance of the Ringelmann or other standard to the same degree, so the smoke still matches the same shade number on the chart.* On this controversial point let's have some first-hand practical reports from smoke inspectors. For example, how closely will several experienced inspectors, working independently, agree as to the Ringelmann shade of a given smoke at a given instant?

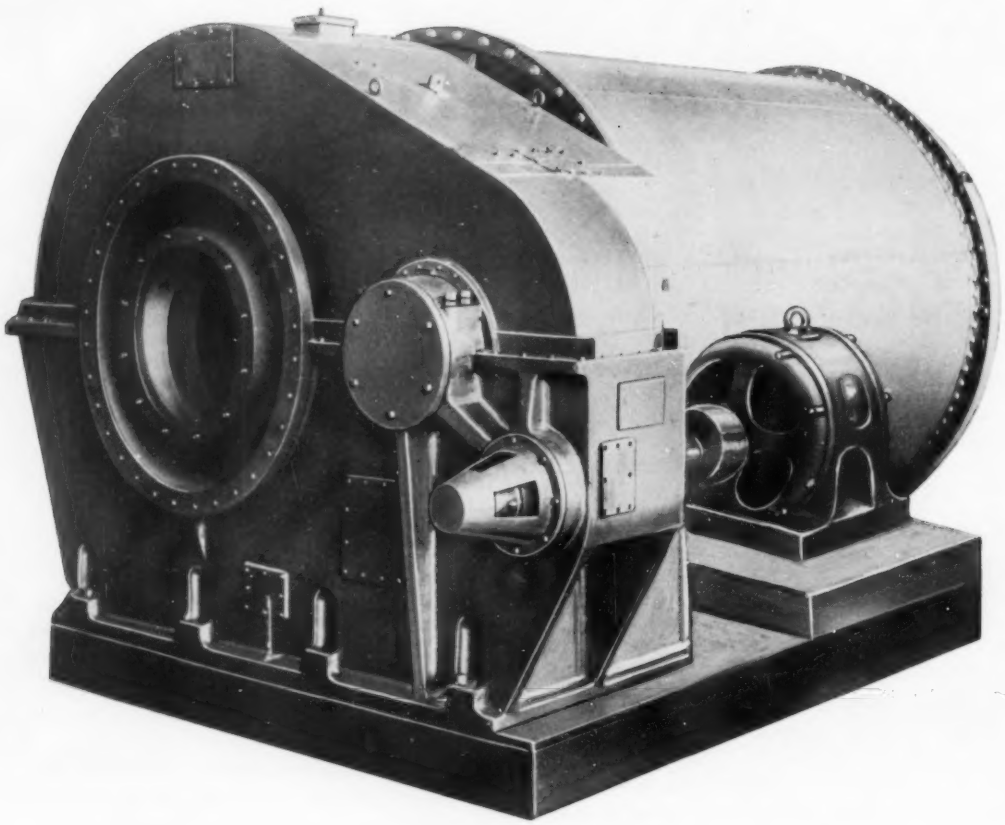
To sum up: Some visual standard is an indispensable part of any effective program of smoke elimination. The Ringelmann gives readings that are reasonably reproducible by experienced inspectors working independently. The main practical objection to the Ringelmann is its inconvenience. The MicroRingelmann is a Ringelmann equivalent in convenient form.

Let's have more discussion, favorable or unfavorable. Above all, let's hear from the engineers who have had extended, practical experience in this field.

Postscript: As we go to press we learn that the New York City Department of Air Pollution Control has adopted the MicroRingelmann as New York City's official standard of smoke density.

KENNEDY AIR

HAVE PROVED THEIR VALUE



Kennedy Van Saun has developed in the course of the last 50 years, methods of fine pulverization of coal with the use of the Air Swept Ball Pulverizer which produces 85 to 90% of the product passing through a 200 mesh seive.

Coarse pulverization of coal is very costly due to high unburnt carbon losses in the ash. Unlike other types of pulverizers, the KVS Air Swept Pulverizer is unaffected by tramp iron and the availability is practically 100%.

KVS Air Swept Ball Tube Mills provides the fine pulverization necessary to maintain clean furnaces and low carbon losses. By using the Kennedy system you can effect savings in coal costs *of more than $1.00 per ton.* Additional savings can be had with increased efficiency.

Consult our engineers for full information.

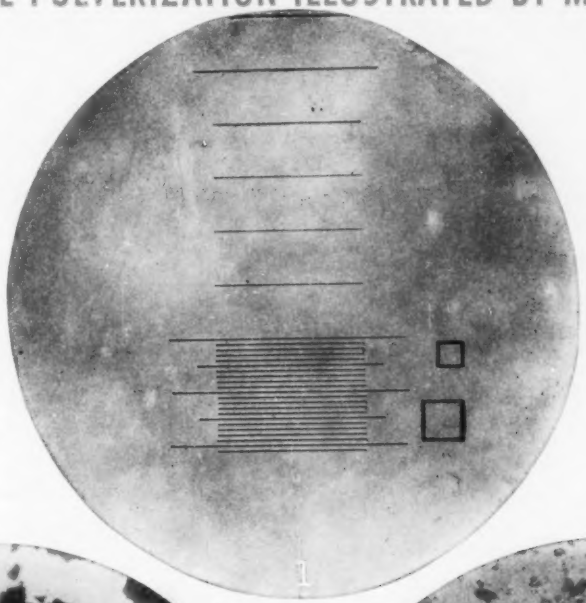
SWEPT PULVERIZERS

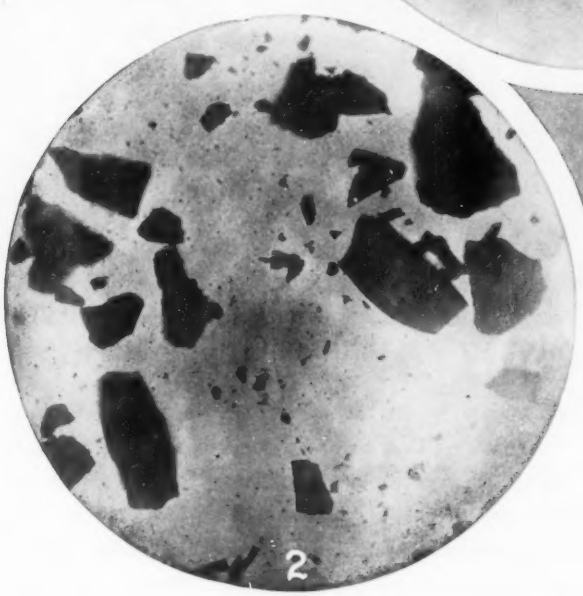
IN HUNDREDS OF PLANTS

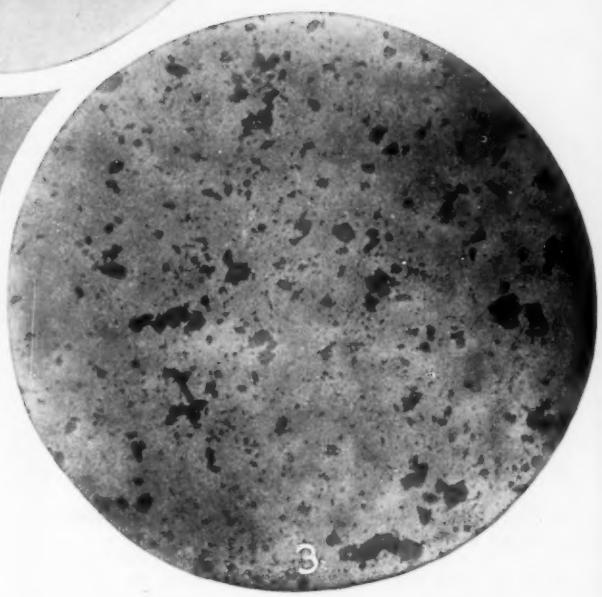
IMPORTANCE OF FINE PULVERIZATION ILLUSTRATED BY MAGNIFIED PHOTOS.

These microphotographic charts, which are magnified 80 times, illustrate the difference between what is usually accepted and actual fine pulverization. Chart No. 1 shows a large and a small square. The large square is the opening in a 200 mesh seive magnified 80 times. The small square is the opening in a 300 mesh seive magnified 80 times. One square inch of a 200 mesh seive contains 40,000 openings. One square inch of a 300 mesh seive contains 90,000 openings, or more than twice the number in the same area. The Kennedy slow speed ball mill produces all fines as shown in chart No. 3. After many years of use the quality of the product remains the same. This cannot be accomplished with other types of pulverizers.

When a high speed pulverizer starts to wear, the product leaving the pulverizer may pass 50% to 60% through 200 mesh. The coal then is equivalent to chart No. 2. The large particles do not burn and result in a high carbon loss. This can be determined by analyzing the fly ash. It is our policy and recommendation that 85% to 90% pass through a 200 mesh seive. The coal *then* burns completely and increases efficiency 2% to 4%. It will pay you to investigate the important savings you can effect in fuel costs with the KVS Air Swept Pulverizer.







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When you buy welding elbows . . .

Why take less when you can get more?

. . . (and at the same price)

ADVANTAGES OF MIDWEST "LONG TANGENT" ELBOWS

- ★ They save pipe.
- ★ They often eliminate short nipples and their extra welds.
- ★ They save time and money in lining up and clamping pipe and fitting.
- ★ They make it easier to apply slip-on flanges.
- ★ They remove the circumferential weld from point of maximum stress and can be sleeved.
- ★ THEY COST NO MORE THAN OTHER ELBOWS.

As shown in the illustration above, Midwest "Long Tangent" welding Elbows have straight ends equal to ¼ of the nominal fitting diameter (a 12" elbow has tangents 3" long). For the reasons listed at the left, substantial savings are made on many piping systems by using Midwest "Long Tangent" Elbows. For more information about them, write for Catalog 54.

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MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

Power
MAY 1954

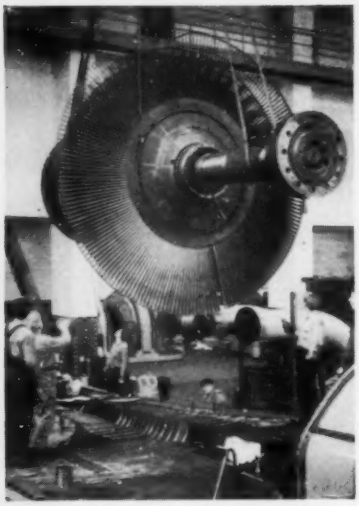
This 3-D camera studies slag

Today's camera techniques save time, cut costs

Here are some phases of your operations where they'll pay:

- **Maintenance—picture sequences help to standardize procedures, simplify working methods**
- **Design, construction—aerial views speed site selection; progress shots coordinate work, record field conditions**
- **Operation, training—stills and movies solve tough trouble-shooting jobs, ease break-in of new operators**

To see how one company gets these benefits, and more, turn page ▶



Standardize procedures

Topnotch maintenance men fully appreciate the importance of proper procedure in periodic overhaul operations. So why rely on the memory of individuals who may or may not be present the next time the job is done? When photographers film each step of the process, you not only have a permanent record, but can also examine the procedures and set up standards that represent the best methods.

Shown here is a typical step in a photo record of a turbine overhaul—hoisting a 40-ton rotor out of its split casing.

Take a camera to the job. Photos cut paper work,

► THERE'S NOTHING NOVEL about using photography in plant operations. Smart engineers have been putting it to work in various ways for years. But before most of us have had a chance to explore all the jobs conventional cameras can do, along come new methods—color, stereo, high-speed photography, for example—to open up a whole range of operations-improving opportunities.

For a bagful of ideas on using today's photo methods in every corner of your plant, take a look at what one outstanding company—De'roit Edison—does with its cameras. Here, in pictures and text, you'll see how well-known procedures are carefully organized for maximum usefulness and how new methods provide answers to some tough problems.

Improving Maintenance. Use of photos to record conditions found during inspection and overhaul is a familiar practice. But Detroit Edison goes beyond this to use the camera for standardizing maintenance procedures and puts 3-D color photos and high-speed photography to work trouble-shooting.

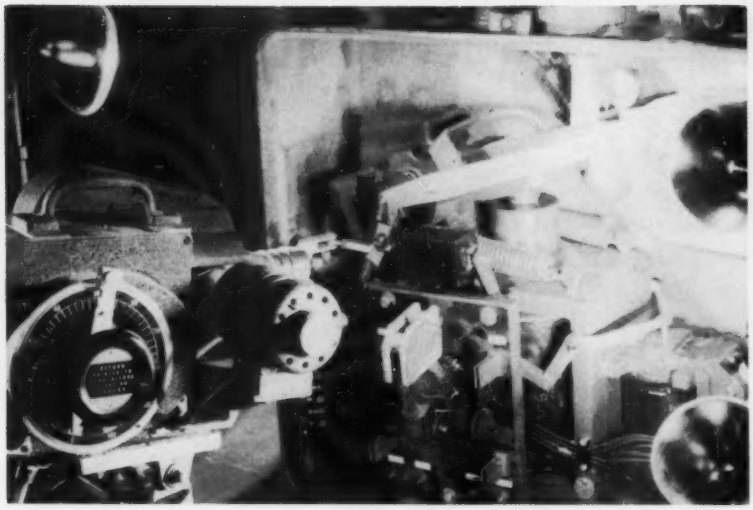
Standardizing good procedures can pay big dividends in the form of high-quality work and time savings. But putting standards into words is a tedious task, and the result may be ambiguous. A series of photos, supplemented with a few key sentences, takes the place of lengthy explanations. Such a *standard* is easy to grasp, more likely to be followed.

Take the case of periodic turbine overhaul as an example, *photo above*. From the time the first bolts are loosened to the time the machine is buttoned up and ready to spin, details of the procedure are spelled out with photographs. And closeups, showing erosion, corrosion, wear, breakage, etc, permit quick engineering decisions as to replacement.

3-D Pictures. When it comes to studying slag build-up in boiler furnaces, special advantages are offered by the relatively new stereo-color camera, *picture on preceding page*. Analysis of these realistic 3-D pictures yields valuable information on firing conditions, helps spot causes of excessive slagging, flame erosion, etc. And they provide a permanent record of exactly what a trained eye would see during a personal furnace inspection.

Any one of several standard stereo cameras using color film will do the job. If you don't have enough work to warrant setting up a lab, developing can be done on the outside.

High-Speed Films. Did you ever *see* water hammer? You may have to, if you're going to protect your piping system



Spot hidden causes of equipment faults

Why is that switch cutting out? This is the type of perplexing problem that often faces the trouble shooter on the job. The defect that causes the difficulty may be one that occurs in a small fraction of a second. The most alert trouble shooter can't spot such split-second action, but high-speed photography often can.

Here's how it worked in this case: The trouble was finally localized in the tripping mechanism of the oil circuit breaker, shown above. A movie camera recorded the action of this defective mechanism. The camera was operated first at normal speed, then at a sizzling 1000 frames a second. When this film was processed and projected on the screen for examination, the secret was revealed: a defective breaker arm appeared to wiggle like a snake under the sharp eye of the lens. When we had pinned down the cause of the trouble, corrective action was relatively simple.

High-speed photography has other useful applications in the plant. The study of water hammer, discussed below, is a handy tool for piping engineers.

Record the conditions

This close-up of a low-pressure turbine's third-stage diaphragm shows excessive erosion. Copies of such photos are sent to engineers many miles from a plant, thus eliminating the need for on-the-spot inspection. They compare this picture with shots of the previous take-down to determine the amount of wear at each point.

After a telephone conversation with the plant operator concerned, appropriate corrective action can be taken. No longer is there any need to wait for lengthy written reports to arrive.

tell quick, true story, now and for the record

and expensive equipment against it. One practical way of studying water hammer is to set up a pressure-resistant glass model of your piping system. If possible, use the same fluid in the model as that in the actual system. If this isn't practical, select a fluid with similar physical characteristics. In either case, it should be strongly tinted with a dye so that it can be seen easily. Often a mixture of water and dye serves the purpose.

After the model is in operation, train the high-speed (1000 frames a second) movie camera on the tinted water slugs as they pound through the pipes. Don't be surprised at what you see when this film is projected. At Detroit Edison they found that these water slugs were creating far greater localized pressures than had ever been suspected. It's not difficult to experiment with alternate piping arrangements that minimize the effects of water hammer.

Another example of the high-speed film technique is trouble-shooting an oil circuit breaker, *shown above*.

Combustion Studies. Determining the correct amount of excess air to use in your furnace is a matter of good judgment based on operating experience. To help you get the right amount of air and set up the best possible firing conditions throughout the furnace, color movies are a useful tool. Flame conditions recorded on film can be examined at your convenience. Studies of this type will not only improve boiler operation, but will also help you stay within the limits of your local smoke ordinance.

In addition to some of the more spectacular jobs, your part- or full-time photographer can frequently be put to good use on a steady bread-and-butter diet of minor equipment-failure shots. It may be a bolt that has snapped off, a valve stem that is working improperly, or a lead cable covering that has failed. Have your man on the scene, recording the incident in a series of photos. It might provide the clue you are looking for, prevent a recurrence of the trouble.

Design and Construction. Two important applications of photography to these activities are shown on p 80. In addition, aerial photos that are translated into detail maps will serve as the basis for foundation-drawing information. Building arrangements and long runs of outdoor piping can also be planned from such pictures.

Construction of Detroit Edison's St. Clair power plant came under the watchful eye of the lens, from the first day

(*Continued at bottom of page* 80)

Where to build?

This is a question that engineers in expanding organizations, large or small, must answer. To come up with the right solution, field men formerly required weeks to check many potential sites. To reduce the time and cost of such checking, engineers have come to depend on aerial photographs to aid in selecting plant sites and transmission lines.

Detroit Edison has had its 7600 square miles of territory mapped by air, resulting in more than 10,000 photographs. Whenever engineers want to study a particular location, they call for photographic blowups that are fitted together to form aerial mosaics, such as the one shown here. It takes a short time to carefully examine these detailed pix. In this way, unlikely locations are eliminated and attention is focused on spots best suited for development.

Construction progress

A complete photographic record of construction progress can prove to be particularly useful both during the construction period, and in later years when expansions and modifications of the original plant are planned. The construction company's headquarters, which are usually remote from the plant site, will be kept in close contact with the progress of the work, through a steady flow of pictures and movies. Filming construction progress of the St. Clair power plant is described in text, beginning bottom of p 79.

Quite often the locations of field-run pipes are indicated only schematically on blueprints. Pipe-location records, in cases such as this, can be made up as a series of photos. Field changes to engineering-department blueprints should also be photographed for reference.

Small plants and large find photos a handy tool

that bulldozers moved in to clear the site until the first of four units was placed in service. Through a steady flow of still pictures and movies, company engineers and the construction firm's headquarters in Philadelphia were kept in close contact with the progress of the work. They were supplied with a full set of photos covering the laying of plant conduit. These will be used for future reference.

Coal-pile inventories are an expensive proposition if you're doing it the hard way. From aerial photos of your coal reserves it's possible to measure volumes that are 96 to 97% accurate. Two pictures of each coal pile are taken and overlapped 60%. A photo interpreter looking through the stereoscopic plotting unit has a 3-D picture of the pile. The resultant view is focused through the plotting unit and a contour map is drawn to scale. The area within each contour line is measured with a planimeter. Since these contours represent known elevations, conversion from area to volume is a simple matter. Coal-pile densities vary depending on the degree of fineness and method of piling, so it is necessary to take several samples from each pile and determine an average density figure for each. With this information, tonnage figures are calculated.

Detroit Edison once required four weeks to complete coal surveys. Now they do the same job in a day of photographing, followed by a short calculation period.

Training operators in the proper use of new equipment

Coal-pile surveys

At one time Detroit Edison's coal-reserves inventories required about four weeks to complete. Now, each spring, aerial-survey firms bid on the job of compiling the data. The firm selected photographs the piles in about a day's time. Photo, *left*, shows aerial pictures being processed with the stereoscopic plotting unit to make up contour maps. Information on these maps is then translated into volume figures. For details of this procedure see text beginning at bottom of p 80.

Cost of these surveys varies, depending on size of piles to be mapped, nearness to airport facilities, and other factors. The speed and accuracy of results have made this method popular in many plants. Even if you have only a few stock piles, economic analysis may show substantial savings are possible.

Visual training

Good instructors know that one of the best ways to put across a lesson is through the use of visual methods. A very handy all-purpose piece of equipment that will help you with such presentations is the visual-cast machine, *shown at left*. This machine projects positive images of photos, drawings, blueprints or other training aids onto a wall or blackboard, and the room does not have to be darkened.

Another valuable feature of the visual cast is that the instructor doesn't have to turn his back to the class when pointing out some detail. He simply points to the item on the actual picture in front of him. An image of the pointer he uses then appears on the projected picture. The machine has been a big hit with Detroit Edison, both to train operators and introduce new equipment.

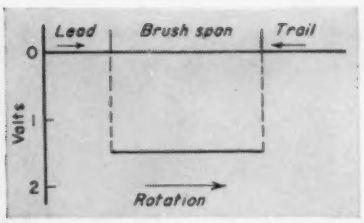
for design, construction, operation, training

pays off in the long run. The smart plant operator needs no convincing on this score. When you *show* how instead of just *telling* how, instructions are far more likely to stick. Movies provide an excellent way of *showing* how. You can give a running commentary on the film yourself. Follow up the film with actual operator performance and inspection of results to make sure your men understand the lesson. The visual-cast machine, *shown above*, is another excellent aid in operator training.

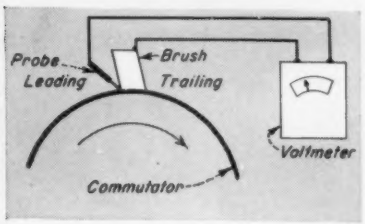
Employe Relations. And don't forget that companies both small and large have put motion pictures to use in personnel relations. Short films are prepared showing employes taking part in company social and athletic activities. These are run during luncheon periods or at some other convenient time. Detroit Edison has filmed a complete power-plant tour in 3-D color. The film proved so realistic that many viewers commented, "Even better than going to the plant." Now Detroiters can see how electricity is produced while seated comfortably in an auditorium or at a luncheon table. And there's no humming machinery to distract.

Chances are you won't be able to use all these photographic techniques in your plant. It may be that to start you can use only a few. But there's no reason why you can't build up as you go along. A relatively modest investment will get you started in the right direction. In the long run you may find the answer here to many a thorny problem.

RECORDING OSCILLOGRAPH and brush probes are the main elements for running test. Potentials between commutator and brush serve as key to accurate adjustments



IDEAL ADJUSTMENT here yields uniform potential distribution across brush face



BRUSH-POTENTIAL setup for measurements under steady load; voltmeter, probe

How to adjust commutation accurately

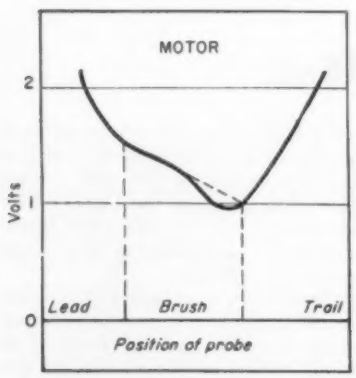
Now you can use brush-potential data to help set brushes on neutral, adjust commutating field strength, even under transient load. Here is complete outline of equipment and procedure

By G H GUNNOE and R M DUNAISKI

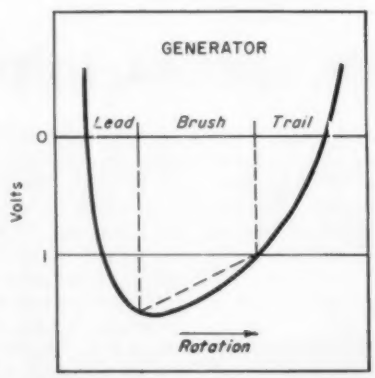
Large Motor & Generator Dept
General Electric Co

► TODAY'S INDUSTRIAL APPLICATIONS of dc machines are calling for faster changes in speed, current and voltage. These needs stem from increased production that plants are reaching for to offset rising manufacturing costs. For example, reversal time of comparative steel-mill equipment has been reduced to half that of ten years ago.

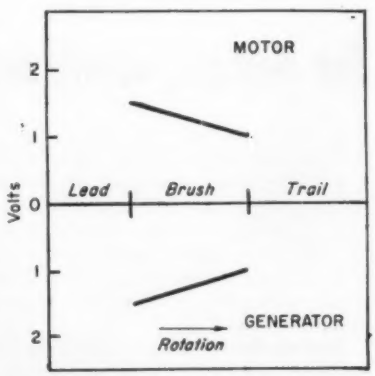
But faster rates-of-change in load requirements directly affect dc-machine commutation. It is becoming increasingly important that adjustments on dc machines be made for transient loads as well as steady-state loading. As outlined in most books on dc machines, there are several methods for determining the proper adjustment under steady-state loads. But no gage or meter was available in the past for successful study of transient loading adjustments.



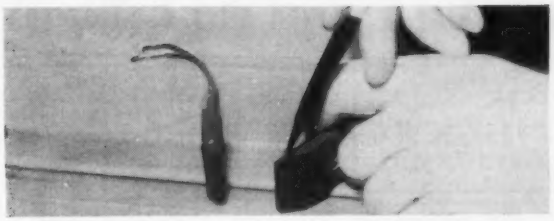
CONVENTIONAL PLOT of brush potentials for typical motor properly adjusted



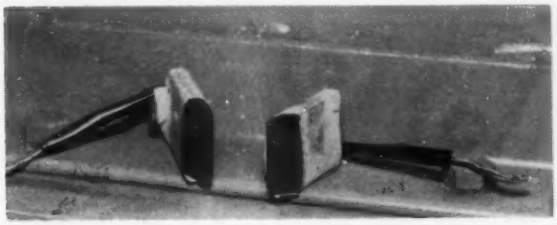
SIMILAR PLOT, *as at left,* but for generator using the general plotting method



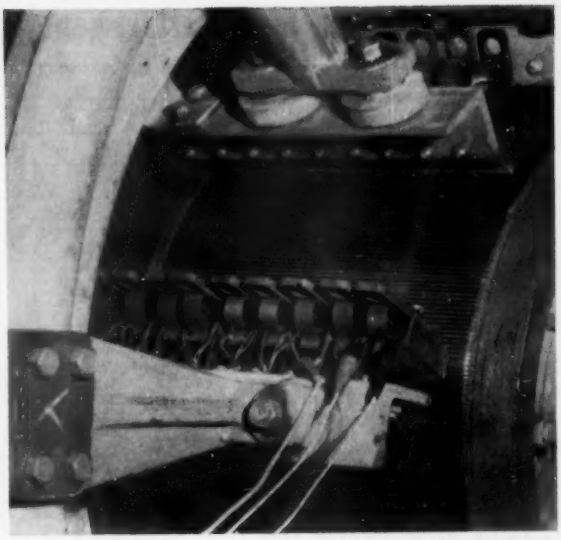
REARRANGING both plots, *left,* eases data interpretation under transient load



BRUSH PROBES made from standard brushes, beveled so that one contacts the commutator at leading, other at trailing edge



INSULATE BRUSHES selected for probes by wrapping thin paper around body of each brush; friction tape to clips and shunt



FLEXIBLE LEADS connect probe brushes to oscillograph. Work carefully since test-equipment case may be alive to ground

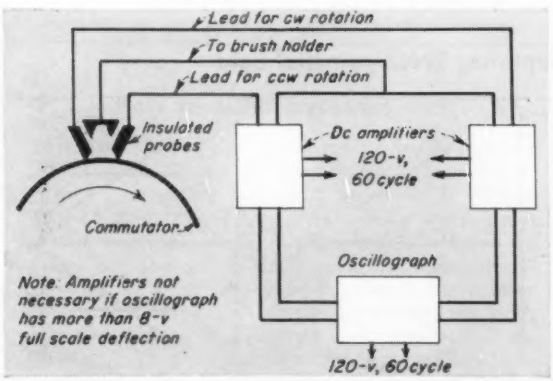
from brush-potential measurements

Visual checking has been the backbone of past adjustment methods. But with varying loads this in itself leaves much to be desired. An experienced electrical maintenance man, skilled in adjustments of large dc machines, will get good end results by visual checking adjustments. But it is often difficult to observe the exact effect of each adjustment.

New Method. Voltage measured between brush and commutator is called the brush potential. It is the voltage drop resulting from current flow through the resistive commutator film. We can break it into two components: (1) load amperes flowing through length of brush (2) circulating current flowing across brush face.

Circulating currents are developed by a brush shorting a voltage difference between commutator segments. This voltage in turn is really made up of two distinct voltages: (1) voltage produced by inductance of armature coils undergoing commutation, reactance voltage (2) voltage generated by coils cutting flux beneath commutating poles. Briefly, commutator adjustments are made to balance these two voltages. Adjustment is ideal when circulating currents are zero, giving a uniform distribution of brush potential across brush face.

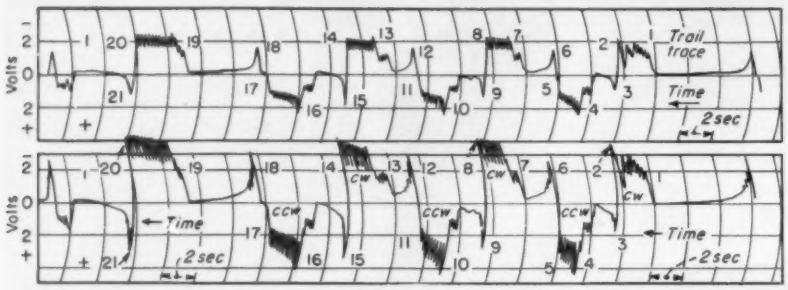
Potential Curves. Theoretical ideal curve does not look like that on an actual machine even when the latter is operating with good commutation. As shown, *top, p 82*, more typical curves plotted for a motor and generator in proper adjustment vary widely from the theoretically ideal. Curve for a ma-



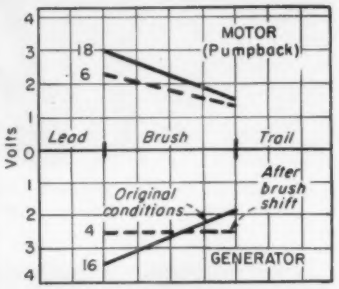
TYPICAL HOOKUP for brush probes, amplifiers, oscillograph. Use ohmmeter to check insulation between probes and holder

TEST EQUIPMENT—amplifiers and recording oscillograph—for brush-potential readings. Note rubber mat under instruments

CASE 1: Uneven load-sharing, generator sparking improved after oscillograph



AS-FOUND RECORDING, *above,* made by connecting oscillograph to *trail* and *lead* brush probes. Significance of data not readily apparent until plotted as at right



COMPARISON of *above* with key plots, *below,* showed unit was overcompensated

Here a 3000-kw 16-pole 750-v dc generator ties in parallel with another machine to power a heay-duty reversing steel-mill motor. A half-bar brush shift was enough to make definite change in brush potentials

I: Brush potential values as found for 3000 kw at low speed

	Generator						Motor (pump back)			
	Clockwise		Counterclock				Clockwise		Counterclock	
Points	Lead	Trail	Lead	Trail	Rpm	Amp	Lead	Trail	Lead	Trail
1	−1.8	−1.2			Start	6000				
2	−3.4	−2.0			End	12,000				
3									+1.4	+0.7
4			+3.7	+2.0	Start					
5			+2.6	+1.1	End					
6							−2.3	−1.3		
7	−3.2	−2.0			Start	6000				
8	−3.6	−2.1			End					
9									+2.6	+1.2
10			+3.7	+2.0	Start					
11			+2.5	+1.2	End					
12							−2.5	−1.4		

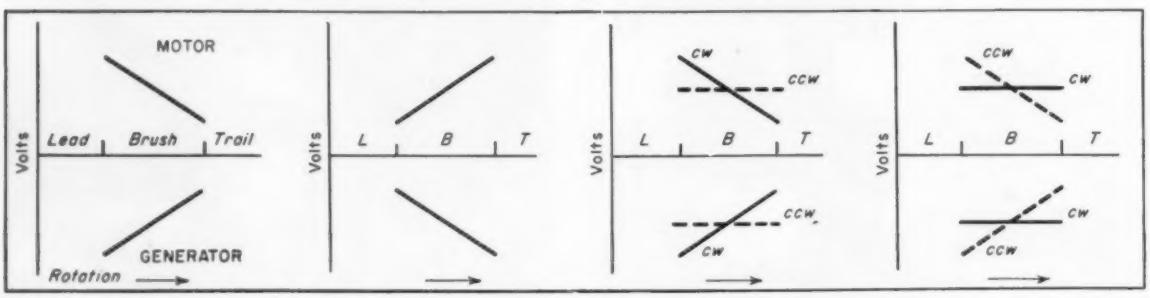
Points 13 through 21 are not included in the above table.

chine operating under steady load can be measured with high-resistance voltmeter and probe. Measurements are taken of brush drop along the area covered by brush.

Generally, machine adjustment can be judged by voltages measured at leading and trailing edge of brush. Basic understanding of brush potentials and method of plotting must be mastered to interpret these data properly. Along these lines of proper interpretation, it is necessary to deviate from conventional method of plotting curves. Regardless of polarity, data for generator and motor are plotted in separate quadrants. This too is illustrated, *bottom, p 82.*

Cardinal Rules. Here are the main rules for interpreting brush-potential data: (1) Higher potential on leading brush edge compared to trailing edge indicates an over-compensated machine—strong commutating field. (2) Higher potential on trailing brush edge with respect to leading edge indicates machine is undercompensated—weak commutating field. (3) Where a machine is called on for reversing service, a variation in brush potential slopes between one direction of rotation and the other

Here are cardinal rules for interpreting brush-potential data



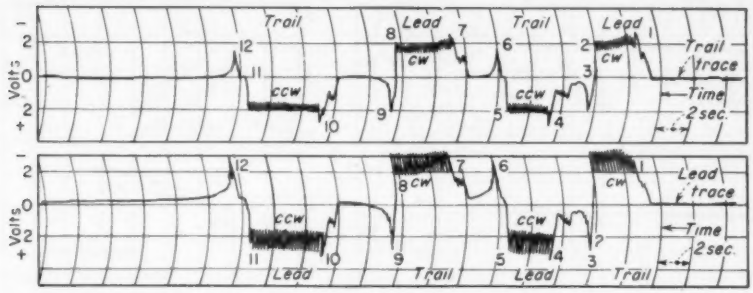
LEAD brush, higher voltage, indicates overcompensation

TRAIL brush, higher voltage, indicates undercompensation

SLOPE variation shows brushes off neutral; shift them cw

BRUSHES again off neutral but now in opposite direction: ccw

recording pointed to slight shift in brush position



AFTER ADJUSTMENT—shifting the brushes one-half commutator bar against rotation —above oscillographic traces were made. Plot shown by dash lines, facing page at top

II: Measured voltages after brushes shifted a half bar

	Generator						Motor (pump back)			
	Clockwise		Counterclock				Clockwise		Counterclock	
Points	Lead	Trail	Lead	Trail	Rpm	Amp	Lead	Trail	Lead	Trail
1	−2.6	−2.3			Start	6000				
2	−2.7	−1.9			End					
3									+2.6	+1.9
4*			+2.6	+2.4	Start	6000				
5			+2.4	+1.9	End					
6*							−2.4	−1.4		
7	−2.7	−2.0				6000				
8	−2.5	−1.7								
9									+2.5	+1.9
10			+2.5	+2.5						
11			+2.2	+1.8						
12							−2.6	−1.5		

*Points 4 and 6 are plotted, top of facing page.

indicates brushes are not on electrical neutral.

These three points outlined apply to machines operating with either steady or transient load. When rapidly varying loads are met, an ordinary indicating voltmeter cannot be used. Reason: response of instrument element is too slow for rapid voltage changes met. And even if a highly sensitive instrument were used, the human eye would not be able to read the needle movement. This points to the need for a recording voltmeter with proper sensitivity. Today, there are several types of direct-inking oscillographs available, quite suitable for this application.

Equipment. There are four pieces of equipment needed for getting brush-potential data: (1) direct-inking oscillograph with two or more elements having a zero centered scale and a maximum response of 120 cps (2) two probes, generally carbon brushes for measuring leading and trailing potentials (3) volt-ohmmeter (4) wire, plugs and jacks to connect into the machine circuit. If full-scale deflection of oscillograph is greater than eight volts, use two dc amplifiers to raise brush potential to a value suitable for reading on recording instrument.

Actually, the volt-ohmmeter listed above is not an essential part of the equipment but is handy for checking continuity and measuring voltages. Use probes to measure potential between commutator and the leading and trailing edge of brush. To make these probes, take two brushes from the same brush stud and grind face of each brush so one contacts commutator at leading edge of brush holder, other at trailing edge. To insulate brush from holder, wrap thin paper around body of each brush-probe, and friction tape around brush clip and shunt. After slipping these now-insulated probes into the brush holder, check insulation resistance between each probe and machine frame with an ohmmeter. Unstable insulation resistance shows up in erratic results. Use the instrument hookup, *p 83*, as your guide in setting up a brush-potential test.

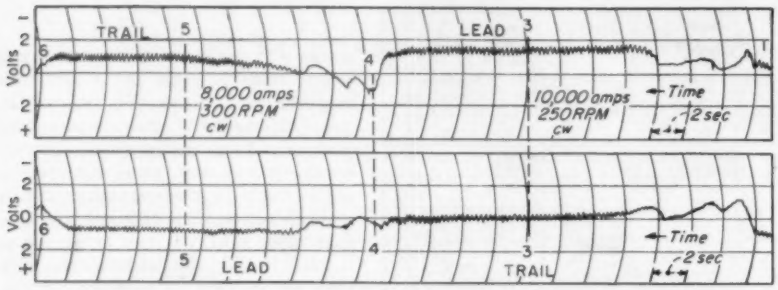
A word of caution: Amplifier and oscillograph cases may be at the same voltage above ground as the brush stud. So both the men running the test and the test equipment itself should be well insulated from ground.

Equipment Adjustment. Follow a detailed procedure in adjusting the test equipment before recording any data. First, remove probe jacks from dc am-

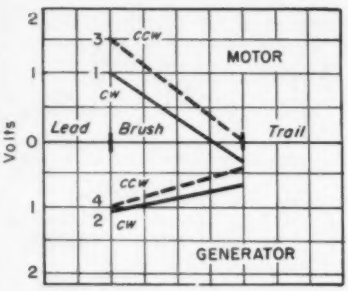
How to avoid erroneous data

When taking brush potentials for the first time, there are many factors that may contribute to erroneous data. *Rough commutator* will shift collection of current toward brush trailing edge. *Raw commutator* will give low over-all values. *Light brush pressure* shows up when no apparent change is made in brush-potential distribution after big change in commutating field or brush shifting. *Faulty brush holders* lead to brush chatter, tend to shift current collection toward the trailing edge. Brushes, unstable in brush box, give symptoms like those for a rough commutator.

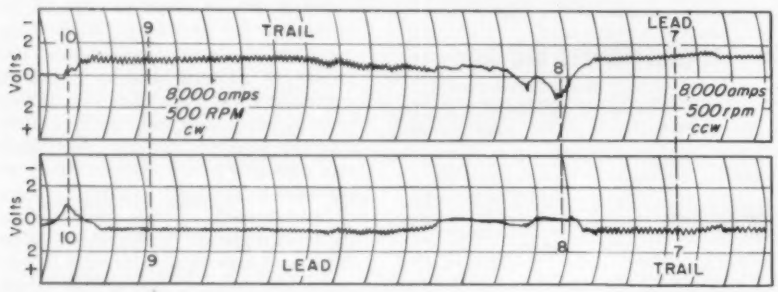
CASE 2: Designed as a generator but operated as a motor, this machine



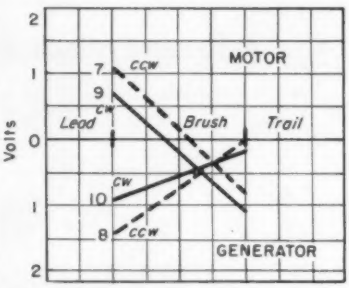
BEFORE ADJUSTMENT this 1500-kw 514-rpm 250-v machine, operating as a motor at 250 to 300 rpm, wore brushes rapidly, while the commutator developed burned spots



BRUSH-POTENTIAL curve shows commutating field too strong (plots bottom p 84)



REVERSING SERVICE, which motor operated under, meant brush potentials needed for low- and high-speed points in each direction. Above recording was taken at 500 rpm



SIMILAR SLOPE curves, each direction, show brushes close to electrical neutral

plifier input connections. Then apply 120-v 60-cycle power to amplifiers. Do this at least one hour before the test to stabilize amplifier output. Connect voltmeter to amplifier output and adjust balance control until you get zero output voltage on amplifier. Repeat this procedure with the second amplifier.

Then connect amplifier output to oscillograph so same polarity will swing both recorders in same direction. Zero-center the oscillograph recording elements with mechanical lever on galvanometer elements. Turn oscillograph on and zero-center recording elements by balance control of amplifier. Set calibrating voltage at 10 on each dc amplifier instrument. Move amplifier attenuator to the 0.1 position to establish a one-volt signal input to each oscillograph element. Press calibrating button on amplifier and adjust the gain control so a deflection of five per volt is obtained on oscillograph. Repeat process on second amplifier.

Note that any variance of gain-control setting causes a minor change in balance control. So any further refinement of the setting must be made with simultaneous adjustments of both gain and balance control in amplifier. Test equipment is then ready for measuring brush potential once the probe jacks are slipped into the amplifier's input connections.

III: Voltage values for original setting of 1500-kw machine

	Motoring						Generating			
	Clockwise		Counterclock				Clockwise		Counterclock	
Points	Lead	Trail	Lead	Trail	Rpm	Amp	Lead	Trail	Lead	Trail
1*	+1.0	−0.3			250					
2*							−1.1	−0.7		
3*			−1.5	0.0	250	10,000				
4*									+1.0	+0.4
5	+0.8	−0.8			300	8,000				
6							−0.6	−0.4		
7**			−1.1	+0.8	500	8,000				
8**									+1.4	0.0
9**	+0.7	−1.1			500	8,000				
10**							−0.9	+0.2		

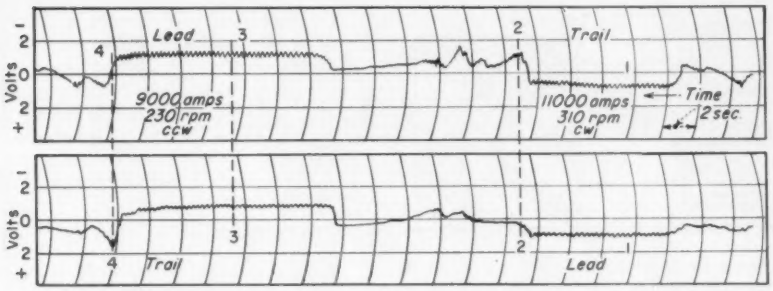
*Points 1, 2, 3 and 4 are plotted, upper sketch.
**Points 7, 8, 9 and 10 are plotted, lower sketch.

Following the above detailed description for getting brush-potential data will give accurate results. But errors can crop in when interpreting the results. Here's where it's important that the observer be acquainted with load's operating characteristics. Example: In checking adjustments of multiple-speed motor the commutating field strength at base speed appears weaker than at top speed. Judging electrical adjustment of this motor without considering speed would lead to a false conclusion. If machine duty is such that observer cannot record periodic changes in speed and current, use a 4-element recording oscillograph. The added two elements allow simultaneous recording of speed and current along with the brush potentials.

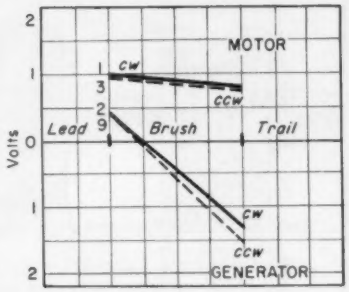
We've found, for the majority of industrial loads, the 2-element unit is adequate for commutator adjustment. Sometimes, where load conditions could not be identified, it was necessary to average values for each condition and plot an average brush potential.

Then to correlate brush-potential data, record following information on oscillograph paper: (1) beginning of load

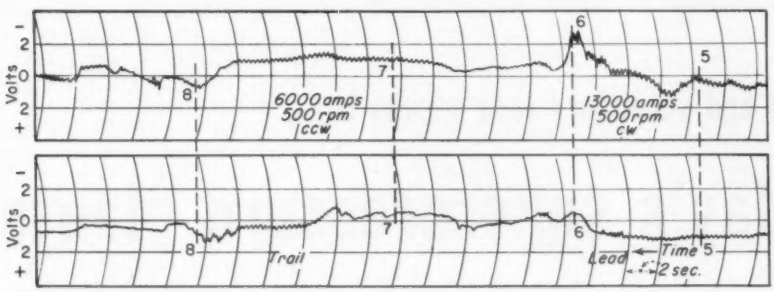
commutated poorly. Trouble cleared by adjusting the commutating field



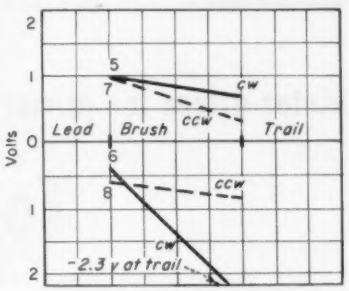
AFTER ADJUSTMENT, by connecting shunt resistor across commutating field circuit, above trace taken at 230-300 rpm. Immediate improvement noted in commutation



IMPROVEMENT is seen (compare with key plots, bottom p 84) for low speeds



SECOND RECORDING made at high speed, 5000 rpm, after adjustment. Six months later the commutator developed a uniform film with no pattern or burned spots visible



HIGH-SPEED plot verifies above. Trail of ccw pump-back trace could read higher

IV: Brush potentials found after adjusting commutating field

	Motoring						*Generating (pump back)*			
	Clockwise		*Counterclock*				*Clockwise*		*Counterclock*	
Points	*Lead*	*Trail*	*Lead*	*Trail*	*Rpm*	*Amp*	*Lead*	*Trail*	*Lead*	*Trail*
1*	+1.0	+0.8			310	11,000				
2*							+0.4	−1.3		
3*			−1.0	−0.8	230	9,000				
4*									−0.4	+1.5
5**	+1.0	+0.7			500	13,000				
6**							−0.4	−2.3		
7**			−1.0	−0.3	500	6,000				
8**									+0.6	+0.8

*Points 1, 2, 3 and 4 are plotted, upper sketch.
**Points 5, 6, 7 and 8 are plotted, lower sketch.

cycle (2) polarity of brush-potential trace (3) lead brush-potential trace (4) approximate current (5) approximate speed (6) end of load cycle. And for reversing machines, record the direction of rotation.

Method at Work. Following are two examples in the use of brush potentials for commutator adjustment based on adjustment while machines are running:

Case 1: Generator brushes off neutral, p 84. Machine normally operated in parallel with a similar unit to power a heavy-duty reversing steel-mill motor. Generator in question was sparking badly and failed to carry its share of the load.

In checking into machine history, we found rotor had been interchanged with that of a duplicate machine. This immediately focused suspicion on brush position. Later, tests verified these suspicions as outlined in the series of charts, *pp 84-85.*

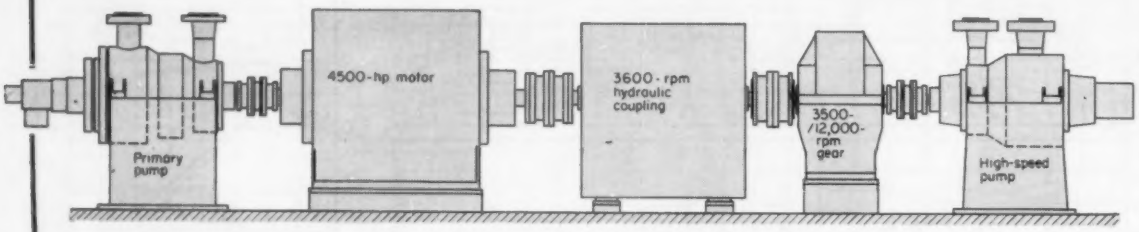
In general, whenever a 2-element recorder is used for brush potentials, you must take many readings to approach an average of load conditions. These readings were taken for this case while machine operator held loads uniform between consecutive passes on an ingot.

Plotting the generator's original adjustment showed machines had a strong commutating field. Brushes were shifted against rotation to weaken this field somewhat. But a shift against rotation also decreases regulation, allowing the machine to take more load. Brushes were shifted one-half a commutator bar against rotation and brush-potential data again obtained. Generator showed immediate commutation improvement and paralleled well with the other generator.

Experience is the major factor in determining how much brushes should be shifted on any one machine. One-half bar shift is generally enough to show a definite change in brush potentials. Results from too small a brush shift may be misleading. Since this generator indicated it was originally over-compensated, changes in compensation alone could have been corrected by changing commutating field strength, but generator regulation would not have improved.

Had we found that brush shifting failed to correct faults, commutating field strength would be decreased since any further brush shifting would make generator take more than its share of load. The over-all improvement in brush-potential magnitudes in this case

(*Continued on page* 250)



1 Setup for a 125,000-kw plant has a single 4500-hp 3570-rpm motor with double-extended shaft to drive primary pump direct. High-speed pump is driven by a hydraulic coupling and 3500/12,000-rpm speed increaser

Motor drives for primary and secondary feed pumps in

Today's superpressure plants

Motors will drive feed pumps in the first U.S. superpressure plant. And similar setups will probably use them within the next few years. But with right controls turbine drive is possible

► OUR SECOND ARTICLE, Feb, pp 82-84, discussed many aspects of selecting drives for superpressure pumps. Since electric-motor drives appear to be preferred at present, and since variable-speed motors operating at frequencies higher than 60 cps are still in the "dream" stage, the only arrangement possible today is a drive using step-up gears and a hydraulic coupling.

Drive Arrangement. Two hookups are contemplated. The first, Fig. 1, has a single motor with a double extended shaft to drive both the primary and secondary pumps. Second, Fig. 2 and 3, has a separate drive for each pump. With it a 4-pole 1750-rpm motor drives the secondary pump, giving slightly more flexibility than with the first hookup.

Here's the equipment needed for each setup in a 125,000-kw plant:

Figure 1

Two sets of pumps, each having:
- 6-in. 7-stage primary pump
- 4500-hp 3570-rpm double-extended motor
- 3000-hp 3570-rpm hydraulic coupling
- 3000-hp step-up gear for 3500 to 12,000 rpm
- 6-in. 4-stage high-speed secondary pump

Figures 2 and 3

Two primary pumps, each having:
- 6-in. 7-stage pump
- 1500-hp 3570-rpm motor

Two secondary pumps, each having:
- 3000-hp 1750-rpm motor
- 3000-hp 1750-rpm hydraulic coupling
- 3000-hp step-up gear for 1700 to 12,000 rpm
- 6-in. high-speed 4-stage pump

Turbine Drive. Problems met during startups of turbine-driven feed pumps appear to be the major objections to this form of drive. One of the characteristics of superpressure steam plants is that about one-third of the normal steam flow must be circulated through the steam generator at full pressure, bypassing the main turbine until steam at rated pressure and temperature is available. So we might, at first glance, decide that the steam turbine is not too practical a drive for superpressure feed pumps because the steam would have to be obtained from another boiler. This hookup is in strong disfavor today.

But one possible solution of this problem consists of using a motor-driven feed pump for starting and emergency service. It would be designed to handle about one-third of the total capacity at the discharge pressure required at one-third flow. It might even be possible to use a constant-speed unit, which would bypass all the closed heaters, handling feedwater direct from the deaerator.

This pump could be selected to meet three separate requirements. During startups it would handle cold water. By the time load reached one-third of rated, it would handle feedwater at about 295 F. Last, if required to act as a standby unit during an emergency to replace both turbine-driven units, it might handle water at 378 F. It would handle water from the deaerator at this temperature until load was reduced and water temperature fell.

Transient Conditions. It should be evident that a large number of problems may arise after initial operation of a superpressure plant. While we cannot hope to foresee all of these, we can and

fifth in this series on superpressure pumps

by Igor J Karassik

Manager, Multistage Pump Section, Centrifugal Pump Division, Worthington Corp

should try to anticipate as many as possible. One important problem is that of transient conditions.

Today, it appears that superpressure plants may secure some advantages by using the so-called open feed cycle with a direct-contact heater at the suction of the primary pump. This hookup is preferred over the closed cycle because startups and protection of the main turbine against feedwater dumping are better.

A bypass valve is fitted to the steam-generator outlet ahead of the turbine pressure regulator. If turbine throttle must be closed, bypass valve can dump one-third of the maximum flow from the steam generator. Some form of reservoir must be fitted so large quantities of heat can be dumped without danger when bypass is open during startup or an emergency. If proper provisions are made in the design of a direct-contact heater it serves as a more practical reservoir than the main condenser.

However, open feed cycles are particularly vulnerable to sudden load reductions, which cause a rapid fall of bled-steam pressure at heater inlet. The check valve between the turbine and heater closes after sudden reduction of load. This isolates the heater from the turbine until heater pressure falls to that of the extraction point for the new turbine load.

During this period, the changing relationship between the falling heater pressure and the feedwater temperature at the pump suction may seriously impair the available net positive suction head, causing serious damage to the feed pumps. A detailed discussion of transient conditions is beyond the scope of this article, but two recent papers* comprehensively outline the problem and its solution. It is essential that full protective measures for the solution of this problem be taken to prevent possible interruption of service in superpressure plants.

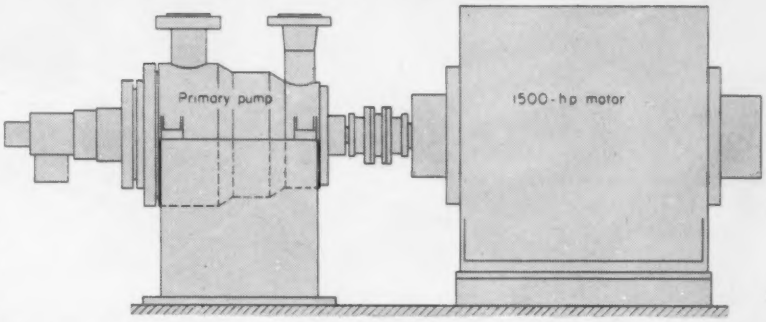
The most promising method of insuring adequate npsh for the feed pumps during sudden load drop is an automatic antiflash control having a group of pressure and temperature sensing elements arranged to measure the difference between the suction pressure and the vapor pressure at the pump suction. This difference is the available npsh and can be constantly weighed against the required npsh. Any fall in available npsh below the required minimum actuates a valve to admit auxiliary steam to the deaerator, Fig. 4. This steam retards the rate of pressure fall in the heater to prevent too rapid a fall from endangering pump operation.

Higher Pressures. Recently published studies indicate further advantages are obtainable with higher pressures and temperatures in the superpressure range. The only obstacle today is absence of suitable materials to withstand the more severe operating conditions. However, plants operating at 6000 psi and higher are within the realm of possibility.

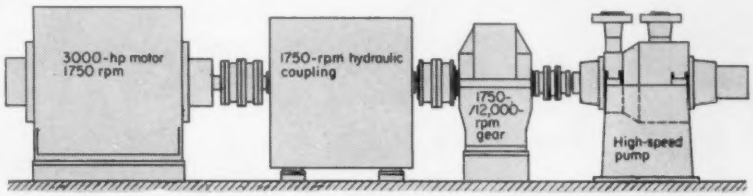
Feed-pump discharge pressures may eventually reach 10,000 psi. Since it appears that 5000 psi is the maximum pressure that can be economically generated in a single casing, it may be necessary to raise the discharge pressure of the primary pump appreciably above the 2000-psi limit we have considered in this series of articles. Certain sacrifices in the first cost of closed heaters will be necessary to avoid the complications of three pumps in series.

EDITOR'S NOTE: *Next month Igor Karassik summarizes major conclusions reached in his five articles in this series.*

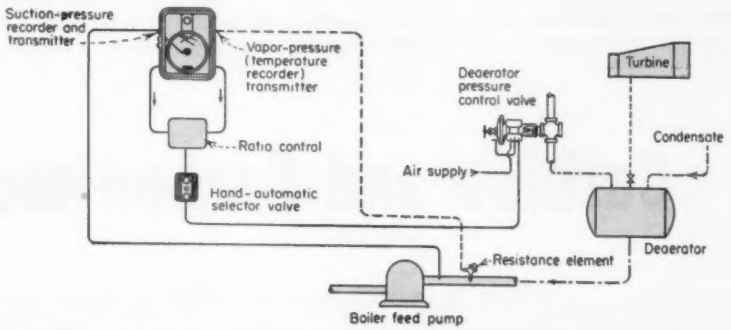
Typical drives and controls for feed pumps



2 Where separate drives are used for the primary and secondary pumps, a 1500-hp 3570-rpm motor is direct-connected to the 6-in. 7-stage primary pump, as shown



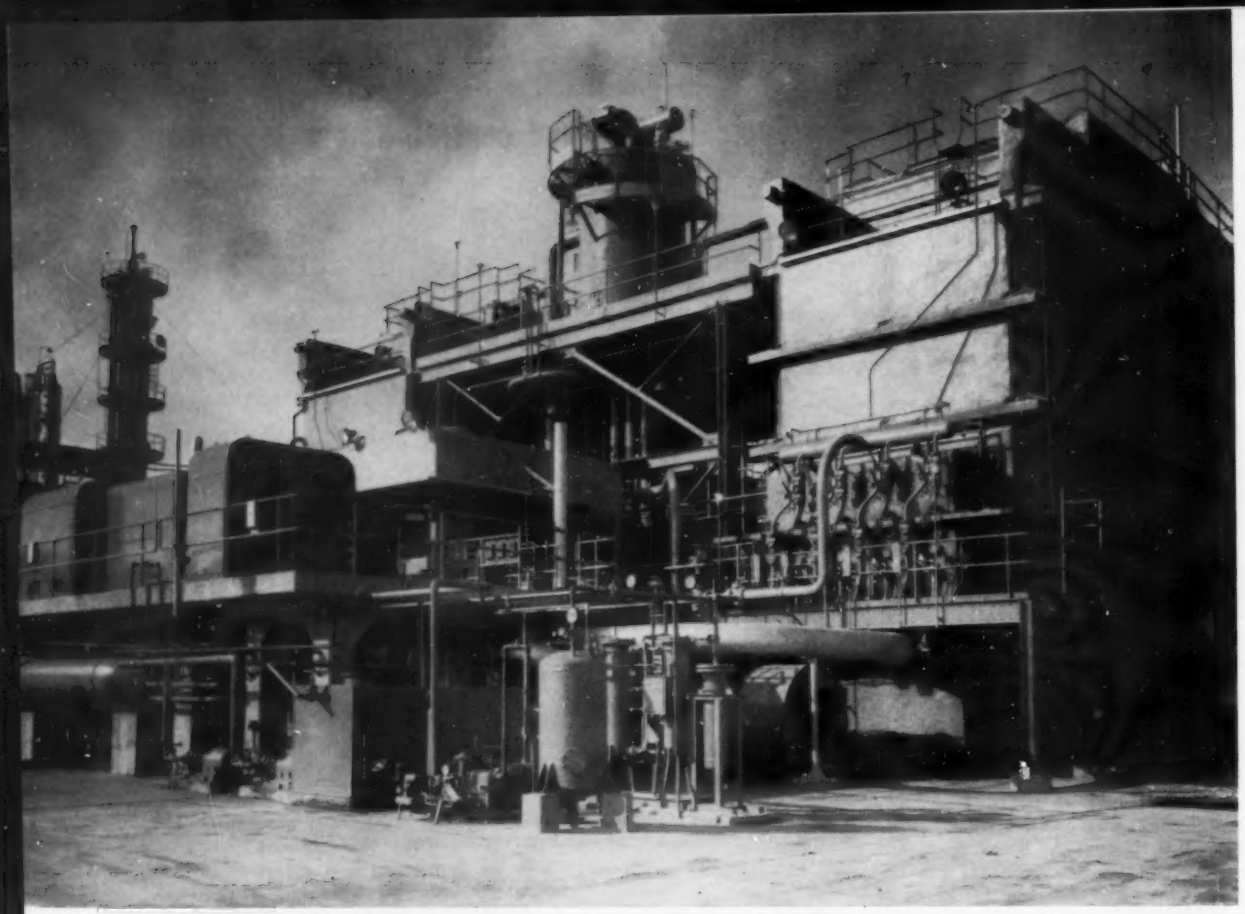
3 The high-speed pump used in conjunction with the primary pump above requires a 3000-hp motor, a 1750-rpm hydraulic coupling and 1750/12,000 rpm increaser



4 Antiflash control hookup constantly measures the difference between the available and required npsh, admits steam to deaerator to prevent feed pump damage

*"Effect of Sudden Load Changes on Centrifugal Boiler Feed Pumps," by Karassik, Bosworth and Schmid. Proceedings of American Power Conference, March 1952.

"Centrifugal Boiler Feed Pumps Under Transient Operating Conditions," by Karassik, Bosworth and Elston. Paper No. 53-F-32, contributed by the power division at the fall meeting, Rochester, N. Y., October 5-7 1953, of the ASME.



OUTDOOR DESIGN of new Texas City power plant places all major equipment except deaerator and flash tanks at grade. Only housing is for control room, turbine-generator exciter walk-in, and battery room. Auxiliaries are in boiler aisle

Carbide and Carbon moves outdoors

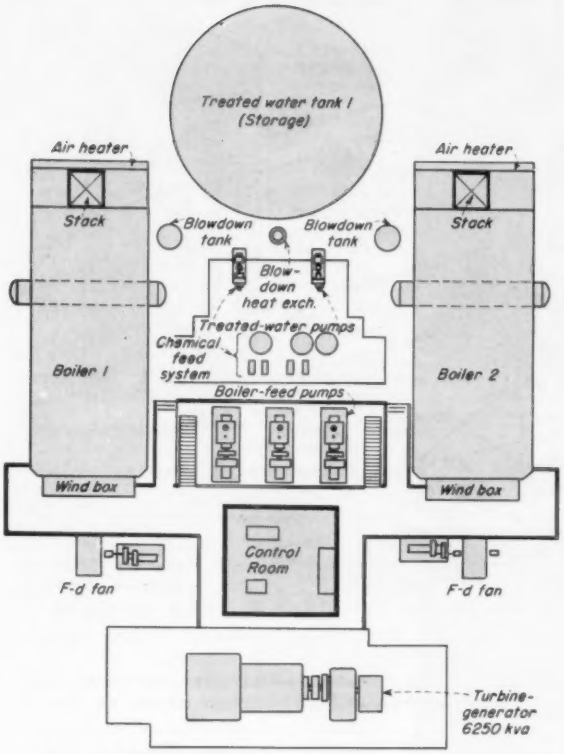
When its Texas City plant called for more power services, Carbide and Carbon engineers leaned heavily on lessons learned with the existing power installation. Result: a new outdoor plant that has reaped the full benefit of operating experiences

► ELECTRICAL POWER AND PROCESS steam are the two power services in ever-increasing demand by chemical industries. In this respect at least, Carbide and Carbon's Texas City plant is no exception. But their latest venture in industrial power departs from conventional practice in several novel ways. To mention just a few: all-welded boiler pressure parts, 1000-psi steam generated from boiler water with dissolved solids content as high as 4000 ppm, 30% continuous blowdown when necessary. We're going to examine some of these unusual features, and also take a close look at how they've made top use of standard procedures.

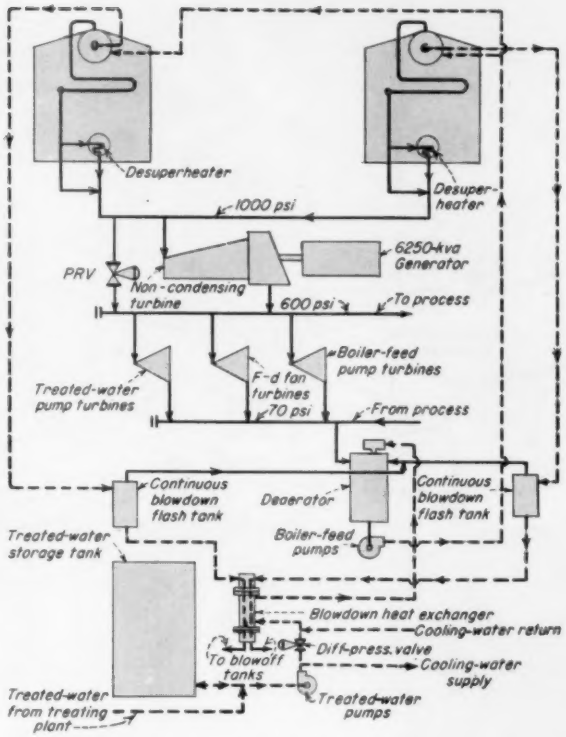
Plant Layout. When it became apparent, early in 1951, that growth of the chemical process would require an additional 400,000 lb per hr of process steam, and 5000-kw electrical power, Carbide engineers took stock of construction costs and operating problems at the existing power plant. The results of careful study pointed to a completely self-contained outdoor plant consisting of two pressure-fired boilers and a noncondensing turbine-generator, together with their auxiliaries. This setup has the marked advantage that unit size, pressure and temperature of future units can be selected without considering the present plant.

Ground-floor plan, *top, facing page,* shows how an extremely compact layout gives complete visibility of all major equipment from the central control room. Notice also that nearness of boilers to turbine keeps runs of high-pressure piping at a minimum.

Flow diagram shows that deaerator



COMPACT LAYOUT gives the control-room operator complete visibility of equipment, keeps expensive piping runs short

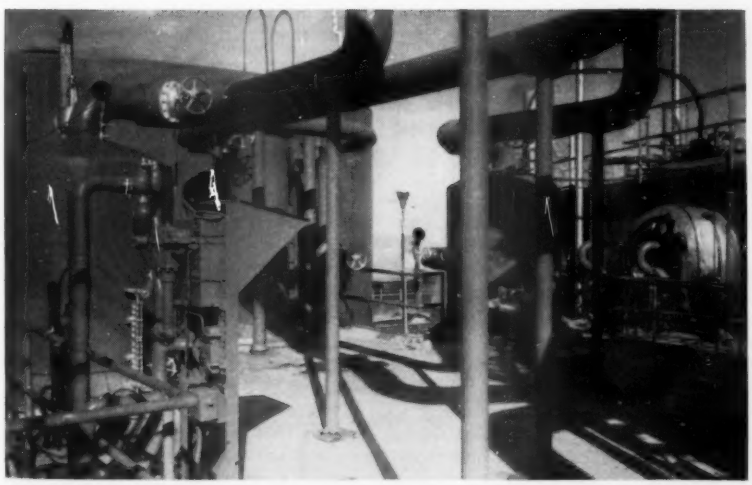


FLOW DIAGRAM of steam and condensate systems shows pressure levels, hookup of equipment, and power-services supply

for low-cost power, process steam

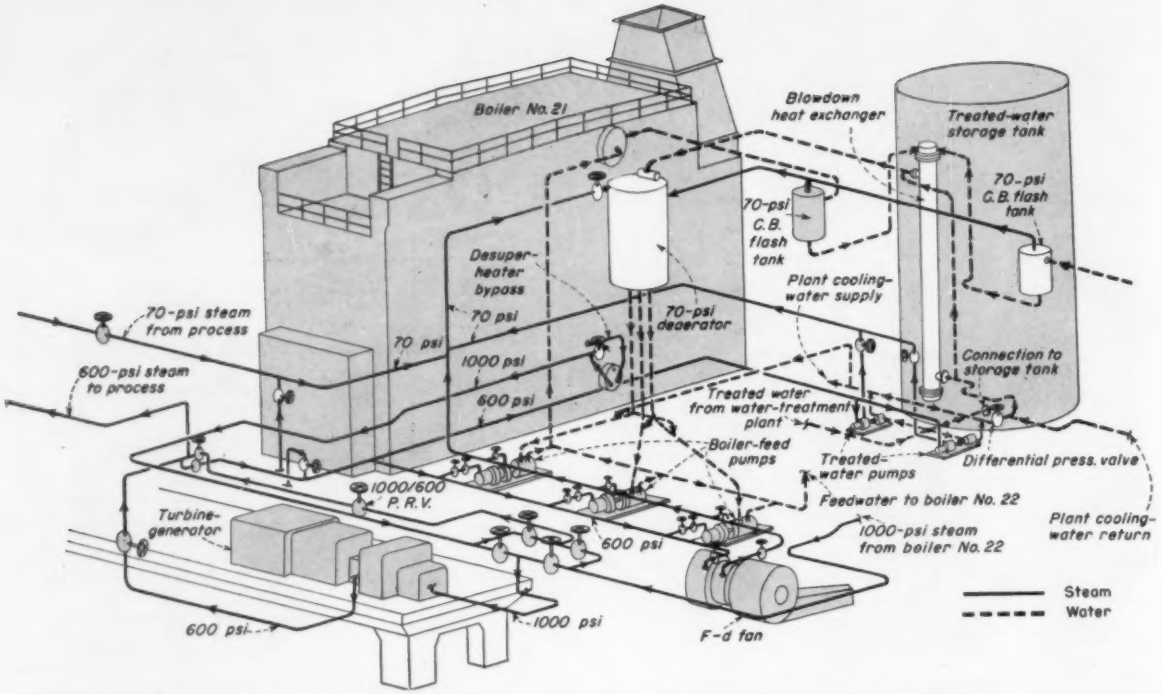
By F G FEELEY, JR, *Mechanical Engineer, Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation*

steam requirement makes the plant a net consumer of 70-psi steam, thus permitting the generation of additional power in the 70-psi backpressure turbines at the original plant. Steam is generated at 1000 psi and supplied to process at 600 psi. Parallel hookup of main turbine and pressure-reducing valve permits continuous supply of process steam—even when turbines are out of service. More than 5900-kw generation would have been welcome, but unusually high solids content of feedwater, frequently above 1000-ppm dissolved



ELEVATED PLATFORM for flash tanks and deaerating heater also gives access to boiler-drum level and provides some protection for ground-level-operating area

More on next page ►



PIPING SYSTEM is arranged for the maximum convenience of operation. Main lines have been laid out along the edges of walkways, making almost all valves accessible without reach rods. Vertical blowdown heat exchanger doubles as pipe run

Piping and equipment layout carefully planned for convenient operation

solids, limited the selection of turbine throttle pressure to a maximum of 1000 psi. Water conditioning consists of clarification, plus softening by cold zeolite treatment, a process that has no effect on dissolved solids content.

Boilers. Two pressure-fired units are rated at 200,000 lb per hr each, at 1000 psi, 850 F, when supplied with 316-F feedwater and burning natural gas. Experience with the original plant showed that internal treatment of extremely high solids feedwater coupled with local zones of high-heat absorption resulted in boiler tube failures.

C&C engineers found that semi-soluble scale deposits in these tubes were caused by only minor variations in the internal treatment—such as might occur in high-heat input areas. The new boilers were, therefore, designed with 100% watercooled furnace walls containing no refractory whatever—not even the conventional access doors. Recent operational tests confirm the belief that furnace heat absorption is now more uniform, eliminating the difficulties experienced with such water treatment.

All boiler pressure parts are welded except tube ends in drums. Only gasketed joints are at one manhead on each drum. Lower drum is equipped with submerged-bypass-type desuperheater that can provide, after pressure reduction, the same heat drop as the turbine.

The continuous blowdown system has been designed to take 30% of boiler feedwater because unpredictable boiler water may at times go as high as 4000-ppm dissolved solids.

Main turbine-generator is completely outdoors with the exception of the direct-connected 125-v 40-kw exciter enclosed in a ventilated walk-in structure. Heat drop in turbine is unusually low —only 76 Btu per lb. Steam flow of 440,000 lb per hr delivers 5900-kw power at the turbine coupling. The noncondensing exhaust is 600 psi.

Piping System. Here's one of the really outstanding features of this plant. All major piping requiring operator service has been laid out at the edges of walkways in such a manner that all but a few valves are accessible without reach rods. Study of drawing above shows how this was done. Notice, incidentally, that double-duty vertical blowdown heat exchanger eliminates vertical piping for both treated water and blowdown effluent.

Main steam piping is ASTM SA-315-48T chrome-moly steel. All steel piping is welded except at certain terminals, and high-pressure-steam valves are of the pressure-seal-bonnet type. Two stop valves at each boiler, one for the turbine and one for the pressure-reducing valve, permit servicing of any 1000-lb valve in the plant without losing the output of more than one boiler.

Two steam connections to the deaerator—one for auxiliary turbine exhaust (which is generally superheated steam) and one for saturated steam from the flash tanks—avoid the evaporation of any carryover in the flash-tank steam by superheated vapors. It was the use of a single deaerator steam connection at the original plant that caused an embrittlement type piping failure.

By keeping the nonflowing-wet leads as short as possible, Carbide and Carbon engineers have been able to use a minimum of antifreeze protection. Electrical-resistance cables provide protection where necessary. Locally mounted pressure gages are protected by internal resistance heaters.

Boiler Feed. Now let's trace the flow of water through the entire feed system. Conditioned water is supplied to the storage tank by a treating plant associated with the original steam plant. One of a pair of water pumps takes suction from this tank and discharges to a 70-psi tray-type deaerator by way of the continuous-blowdown heat exchanger. In addition, a portion of the cold water is shunted off for cooling purposes by a differential-pressure valve before the heat-exchanger inlet.

While some heat is recovered by this arrangement, the main purpose of using treated water for cooling is to promote cleanliness of heat exchangers. Having recovered waste heat in the cooling and blowdown systems, feedwater is deaerated and drops directly down into the suctions of barrel-type 6-stage boiler-feed pumps that discharge to the boiler drums. Pumps can deliver 320,000 lb per hr each at 5000 rpm. Critical parts are of high-chrome nickel steel, and smothered leakoff bushings are used instead of packing.

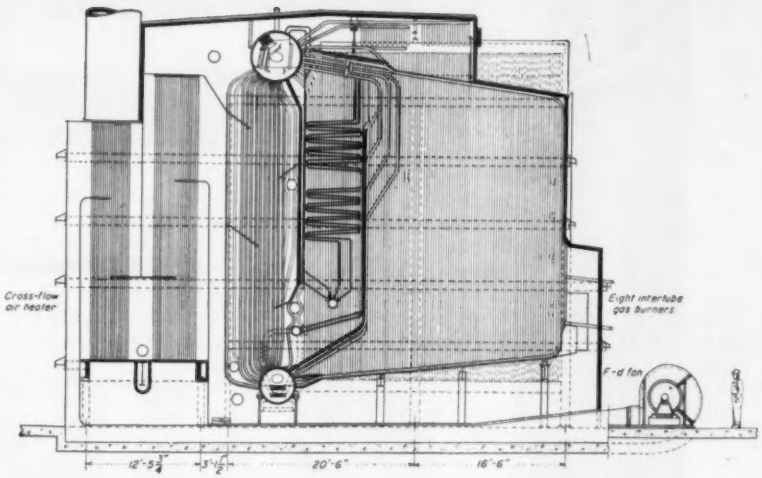
Mechanical Drives. Availability of 600-psi steam and need for 70-psi steam in the deaerator makes the use of turbine drives for auxiliaries economically attractive. Hookup diagram shows that f-d fans, boiler-feed pumps, and treated-water pumps are steam driven between these pressure levels.

All auxiliary turbines were hydraulically governed for speed, but these systems have been shelved in favor of the simpler pneumatically operated speed-control valve — throttling inlet steam directly. Treated - water - pump drives have carbon seals, but all other turbines are equipped with labyrinth packing. These are served by an extension of the turbine-generator gland leak-off system, which is simply a surface condenser evacuated by one of a pair of motor-driven vacuum pumps. Drainage from this condenser is collected in a sump together with that from the feed-pump leakoff bushings. It is then picked up by drain pumps and returned to the treated-water pump suctions. Net result is a group of machines that is largely free from the conventional causes of small-turbine outage.

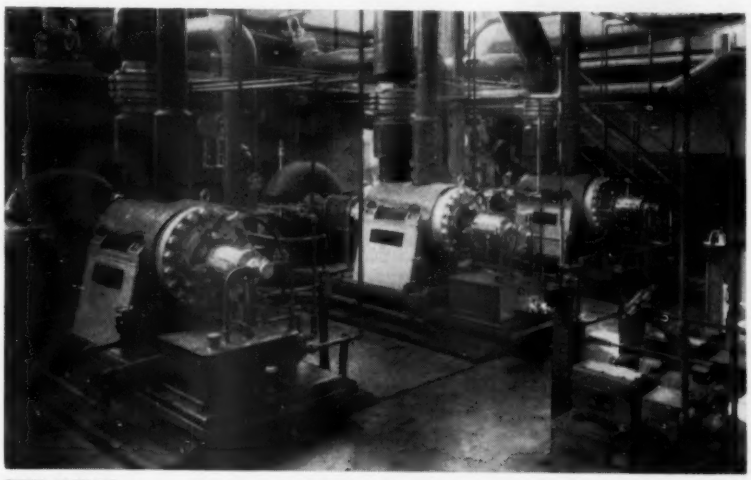
Automatic Controls. The latest in automatic and remote plant operation is represented here. Photo, *at bottom right*, shows layout of control room.

Combustion control is steam-pressure responsive, through master regulators—one on each boiler with a switch to select the master that will control the plant. Fuel-gas-to-air ratio is balanced by direct measurement. Fuel follows air so that a fan failure cuts off fuel supply. Air-flow regulation is by f-d

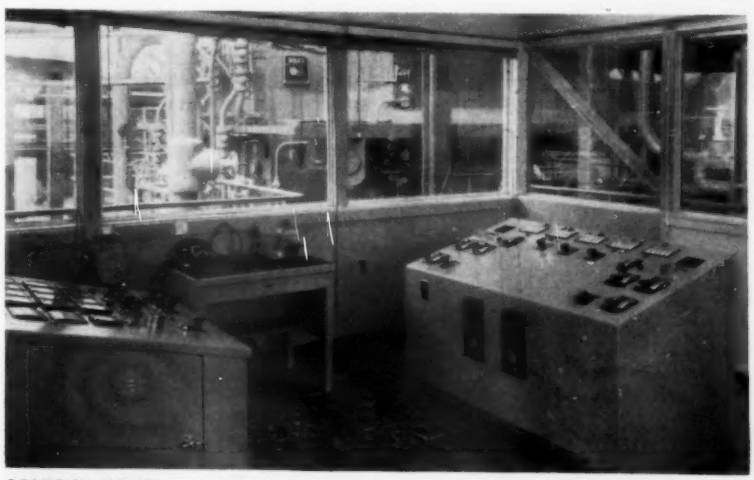
(*Continued on page* 230)



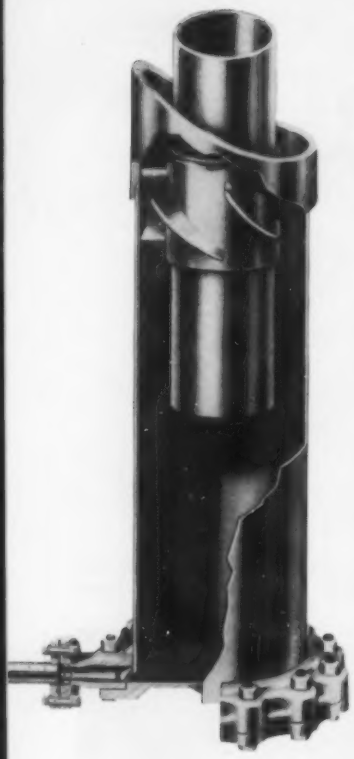
BOILER DRAWING shows how the foundation and lower casing form the cold and hot air ducts, making it possible, at low cost, to keep f-d fans at boiler fronts



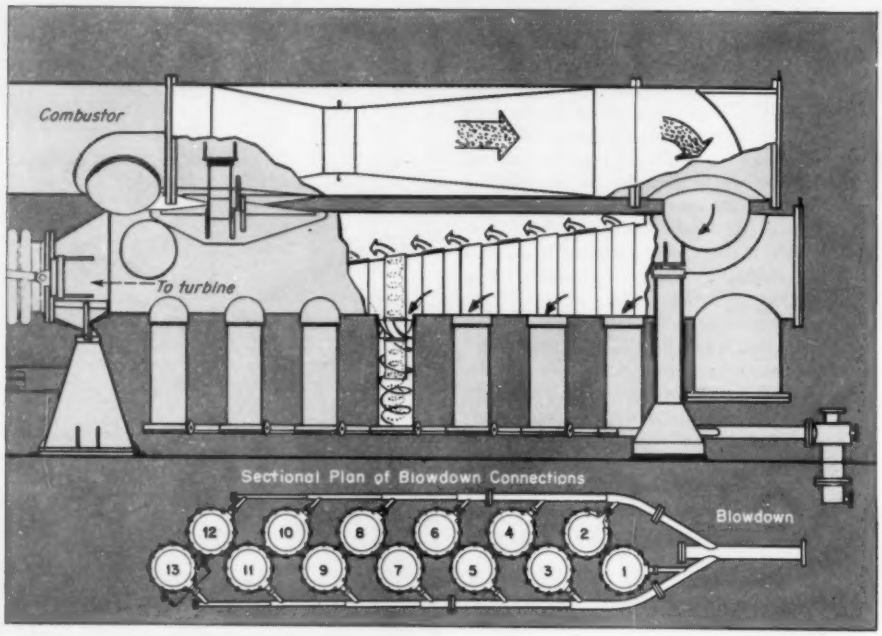
FEED PUMPS are arranged so that each outboard pump can serve only its adjacent boiler. The center pump is a common spare. Critical parts are high-chrome-nickel steel



CONTROL ROOM consoles provide operator with means for remote supervision of plant. Enclosure is conveniently located between boilers and turbine-generator



Improved separator tubes in new layout...



The coal-burning gas-turbine project:

► OVER 2000 HOURS of direct-fired coal-burning experience on full-scale gas turbines have now been accumulated by the Locomotive Development Committee. Five 250-hr tests were run on a Houdry-process turbine loaned by the U.S. Bureau of Mines (POWER, June 1951, pp 104-107; May 1950, pp 80-82). On the 4250-hp Allis-Chalmers locomotive-type power plant (POWER, Aug 1951, pp 90-91) the total is 832 hours, of which 750 hours were at high load with coal only.

After results of 750-hr test were evaluated, American Locomotive Co expressed interest in joining LDC in continuing the project. A 3-part program was proposed, leading to further turbine tests with improved coal-handling and ash-separation equipment.

LDC-Alco program for 1953-54 divides into three parts, with costs and responsibilities allocated as follows:

Coal supply: LDC to develop methods of supplying gas-turbine locomotives with suitable coal and to make certain revisions in coal-handling equipment of the test plant located at Dunkirk, N. Y.

Ash separator: Alco and LDC jointly assume responsibility for developing and installing a new flyash separator and improved test-plant instrumentation.

Turbine test: Alco took responsibility for providing needed new blades for LDC 4250-hp turbine and for conducting a series of turbine tests using the new separator.

Coal-Supply Study. Original goal of LDC program was a self-contained locomotive power plant which could process and burn bituminous coal of any kind, size and moisture content. Operating experience shows that little if any restriction need be placed on kind of coal, but a more realistic requirement must be established for size consist and moisture content. Coal must be free flowing when it reaches the locomotive bunker, without foreign matter that can interrupt supply. Somewhere between the coal seam and the gas-turbine combustor, coal must be pulverized to at least 95% minus 100 mesh.

An LDC subcommittee is reviewing the entire problem of coal supply. Cost estimates and economic evaluations are being made of the various systems proposed for supplying "gas-turbine coal."

Test-Plant Setup. Pulverized coal for the next turbine test program will be supplied by equipment used during the 750-hr test, rearranged to separate stoker and pulverizer from direct connection with turbine feed tank. Pulverizer delivers through a cyclone separator into a large storage tank. Separator vents through a dust collector and a screw conveyor returns fines to storage tank. A pneumatic conveyor transfers pulverized coal to turbine tank.

LDC rotary coal pump (described in previous POWER articles) feeds from the scale-mounted turbine-feed tank into a conveying-air line, which supplies twin combustors. Flexible connections permit weighing the tank and determining coal-consumption rate accurately. A variable-speed electric transmission drives the coal pump and thus serves as the turbine "throttle."

Ash Separator. During the first 178 hours of operation on the 4250-hp turbine, no appreciable blading erosion occurred. Ash separator functioned continuously at top efficiency and ash particles entering the turbine were virtually all smaller than 20 microns. But early in the 750-hr test a leak occurred in the separator and serious erosion

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Condensed from a report to Bituminous Coal Research, Inc. by John I Yellott, Director of Research, and Peter R Broadley, Asst Director of Research, Locomotive Development Committee, BCR.

...aim at full blowdown to keep up ash-removal efficiency

When the LDC-Alco program was set up, it was realized that the separator was the key to successful operation of the direct-fired coal-burning gas turbine. So to the Development Laboratory went an assignment to (1) improve the Dunlab separator tube (POWER, June 1951, pp 104-107) and (2) develop an ash-blowdown system that wouldn't clog.

Dunlab Tubes. In hundreds of tests at full turbine temperature (1300 F) all tube dimensions were varied systematically. Original dimensions turned out to be close to optimum. But when the original tangential blowdown line was replaced by an annular one, a major improvement resulted. In this scheme (see facing page) an annulus surrounds the tube bottom, with a ¼-in. gap between cylindrical barrel and flat bottom. A radial blowdown line, ¾ in. diameter, carries separated ash away from the annulus. Particles larger than ¼ in. can't pass this gap. Instead, they swirl around in the tube until reduced sufficiently by attrition.

For top Dunlab tube efficiency, air flow through blowdown line should be above 12 cfm. If this drops below 10 cfm, some of separated dust is re-entrained and carried out the clean-air discharge. Loss of efficiency in original tubes during the 750-hr test was apparently caused by gradual reduction of blowdown flow below the 10 cfm needed.

To keep this from happening again, blowdown flow is now measured continuously without interfering with tube operation. This is done by taking pressure drop across taps in the annulus casting: one in the elliptical section where blowdown line leaves annulus, the other in the smaller cylindrical section just ahead of the outlet flange.

Ash separator used in the 750-hr test consisted of a battery of 26 Mark I Dunlab tubes in a large Inconel X pressure vessel. Blowdown lines connected to two manifolds brought out through the pressure shell. It was thus impossible to check performance of individual tubes during operation, and obstructions in the blowdown lines could be removed only by shutting down and opening up the shell. In new multitube separator individual tubes are pressure-sustaining elements and expensive shell is eliminated.

Since total air flow to turbine is almost 40,000 cfm, and each Dunlab tube handles 1500 cfm, new separator uses two 13-tube batteries in parallel (*diagram, facing page*). Body of each separator is a 28-in. horizontal cylinder divided by a slope sheet into a lower dusty-gas inlet and an upper cleaned-gas outlet chamber. Ash-laden hot gas from combustor enters lower part of separator through a tee, and finds that only exit is through the Dunlab tubes. Vanes at tube entrances cause air and ash to spin rapidly; centrifugal force throws ash toward tube wall. Most ash particles enter annulus and flow out with blowdown stream; cleaned air and ultrafine ash particles spin up through discharge.

Blowdown lines connect into manifolds; bushings of graduated inside diameter equalize blowdown flows. Manifolds lead to ash concentrators, which divert ash and some blowdown air to disposal system. Remaining air goes out stack.

Where it stands today...What's ahead

took place. When the leak was repaired and high-load operation was resumed, separator performance was found to be quite erratic and consistent operation at high efficiency couldn't be maintained. At conclusion of the test, discharge manifolds were cut apart and obstructions were found. This led to development of an improved separator design, as described above.

Instrumentation. In preparation for next series of turbine tests, improvements have been made in test-plant instrumentation. A large venturi tube has been put in compressor air intake to measure total air flow to the plant. Venturi tubes have also been placed in combustor extensions leading to each of the separators so air flow through the two halves of the system can be checked for equal division.

Continuous determination of separator performance will be of utmost importance in coming tests. So ash samplers have been put at entrance of each separator, in addition to samplers at turbine inlets. Comparisons of weights of ash caught at these points will enable operators to calculate actual separator efficiency. Since there is a close correlation between amount of ash entering the turbine and particle size distribution, samples of ash from turbine inlets will be examined frequently by microscope, to check percentage of plus 10- and plus 20-micron particles.

Detecting Erosive Ash. Two new methods of detecting erosive ash will be used. Early in 1953, a project was set up at Armour Research Foundation to develop better and faster methods of determining erosiveness of ash particles entering the turbine. Two methods were selected: One uses change in electrical resistance of a rod exposed to erosion in turbine inlet stream, the other uses radioactivity.

In the radioactive method, samples of dust-laden air from the two turbine inlets are directed at high velocity against small irradiated targets of S-590, the alloy used in cylinder blading. Air streams are then led through slowly moving filter-paper tapes, where ash and removed metal fragments are caught. Scintillation counters scan the moving tapes continuously and indicate radioactivity of the observed portion of tape in "counts per minute."

If ash impinging on targets is nonerosive, count rate will be quite low, corresponding to the background at the test location. If ash is coarse and erosive, count rate will go up in direct proportion to amount of irradiated blade material "seen" each minute by the scintillation counter. A continuous record of count rate will be kept and an alarm sounded if it exceeds a predetermined value. Speed is the great advantage of this method—less than one minute is needed to detect presence of erosive ash.

New Turbine Blades. At end of 750-hr test it was found that new blades were needed in first four rows of the 4250-hp gas turbine. Alco assumed responsibility for producing and installing the new blades. The Operations Committee decided that cylinder blades

(*Continued on page* 246)

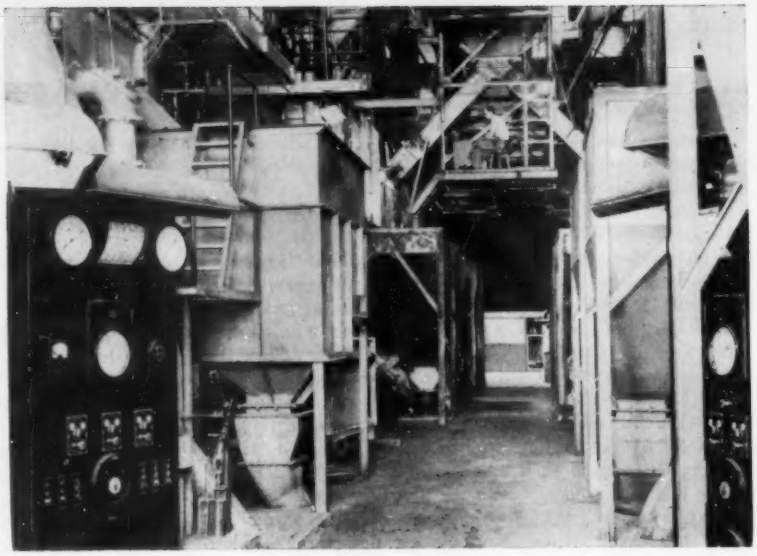
INDEXES AVAILABLE

A limited number of editorial indexes for 1953 POWER are now available. No general distribution can be made, but if you wish a copy, just drop us a letter or postcard and we'll send one.

Old

A 2-ton weigh larry supplied boilers on either side of central firing aisle from a 500-ton suspended bunker at west end. Storage at boilers was limited to floor hoppers (4 to 6 tons each), which fed pulverizers in basement.

Coal came in by rail to a track hopper, from which a 100-tph skip hoist lifted it to the suspended bunker (see drawing on facing page). A spare 40-tph bucket elevator was installed at west end of the bunker in 1949 for the stand-by yard-recovery service.



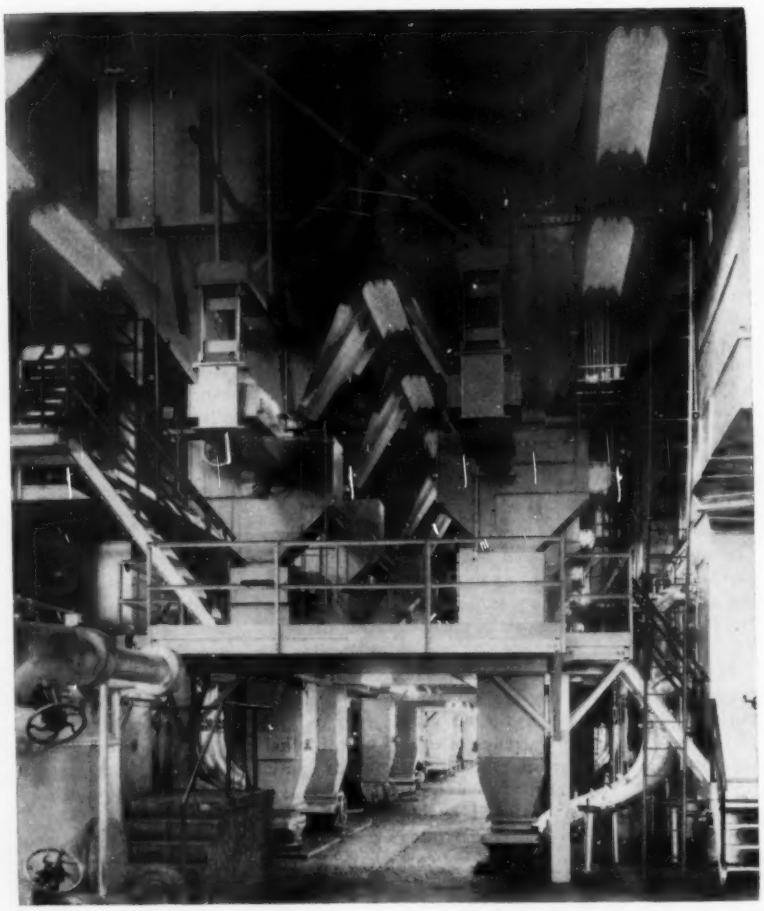
From OLD... to NEW: How

New

Bright and spacious, present firing aisle has four multiple-hopper-bottom top-suspended bunkers (125 tons net, each) feeding through modern coal scales on a new platform. An under-bunker conveyor on each side makes it possible to feed any pulverizer from any hopper outlet in the same row. From the scales, coal flows down through chutes, fitted with gates and "no delivery" alarms, to pulverizers in basement.

In contrast to the old larry setup, new system cuts labor for coal handling to a minimum, keeps plant clean. Greatly increased "local" storage, inside and available by gravity flow, plus versatility of under-bunker conveyor, makes operation much more flexible and virtually eliminates risk of outages caused by interruptions of coal flow to pulverizers. Capacity is more than adequate for enlarged plant.

To see how this new equipment ties in with portions of old handling systems that were retained, see drawing at bottom of the facing page.



Frigidaire cut coal-handling costs

The problem:

Reduced costs, increased reliability and operating flexibility, more space and a cleaner plant—these were the major goals of Frigidaire engineers when they set about revamping coal handling at the Dayton plant of this General Motors division. And they wanted to get all handling inside the plant, particularly more inside storage available by gravity. While they were doing this, putting in some new boilers, and generally modernizing the plant, they had to keep running, so the job called for skilled planning.

To see what conditions were when this project got under way in 1950, let's take a quick look at the plant's history. First section of the plant (area now occupied by present No. 1, 2, 7 and 8 boilers) was built in 1917. It housed eight battery-set 2500-sq-ft boilers. Second section, at west end, went in nine years later (1926). This time four 7220-sq-ft units were installed. Except for conversion of two battery-set units to pulverized coal, this general setup served until 1938. But during the next ten years four new and larger pulverized-coal-fired boilers replaced all 1917 battery-set units and two 1926 units were removed to make space for air compressors.

Thus, in 1950, four of the present boilers were in service (drawing below). These were: No. 1 and 2, 80,000 lb per hr each; No. 8, 100,000 lb per hr; No. 7, 120,000 lb per hr. The two remaining 1926 units were scheduled to be replaced by present No. 3 and 4 (90,000 lb per hr each). Then air compressors were to be removed and present No. 5 and 6 units (90,000 lb per hr each) were to be installed.

With these changes in the wind, it was clear that existing larry-and-floor hopper system (*photo, facing page*) would be inadequate. Replacing it promised to get rid of several drawbacks: (1) Capacity of floor hoppers was limited, they were unsightly and took valuable floor space. (2) Larry operation boosted manpower needs and made it hard to keep the plant clean. Besides, it wasn't big enough for greater coal needs and a breakdown would be crippling. These limitations of the handling system, and the fact that Units No. 1 and 2 had only one pulverizer each, made plant operation inflexible, increased possibilities of outage, and ran up costs.

The solution:

Weak links in old handling system, which dated from 1926, were the weigh larry and floor hoppers. Remainder of system was retained and tied to new equipment as shown in drawing.

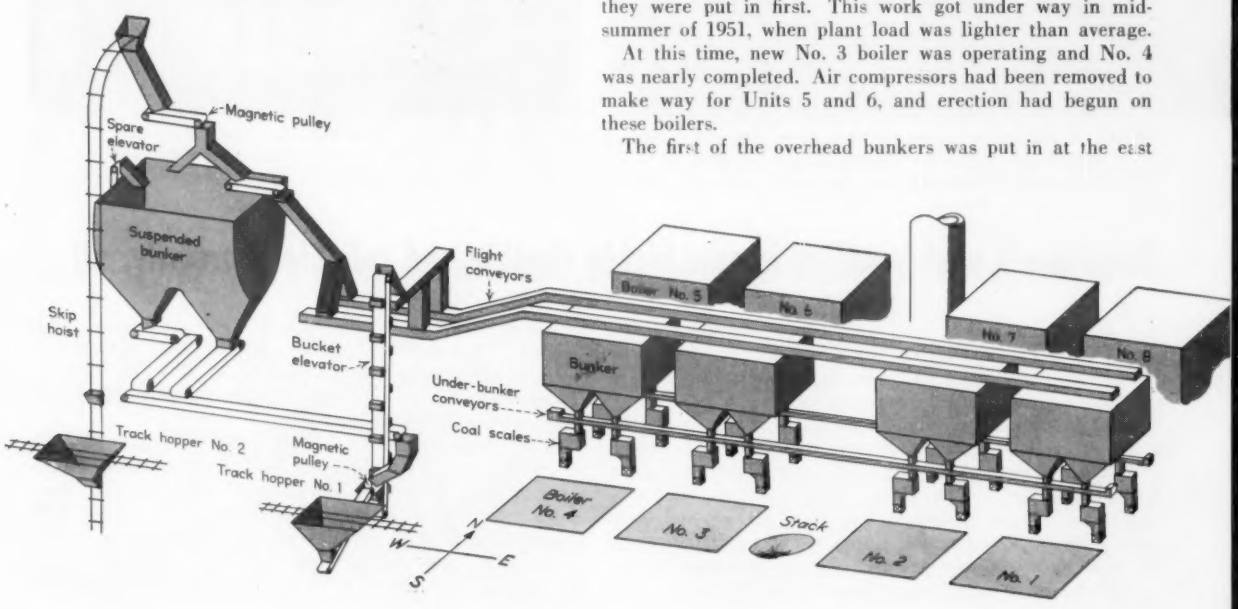
As the system now stands, coal can come into the plant by way of new track hopper, feeder conveyor and 100-tph bucket elevator, or by old track hopper and skip hoist or spare elevator. Skip can discharge directly into old suspended bunker, or by connecting conveyors to 100-tph flight conveyors distributing coal to boiler bunkers. Conveyors connecting suspended-bunker outlets with new bucket elevator can take coal from suspended bunker to flight conveyors.

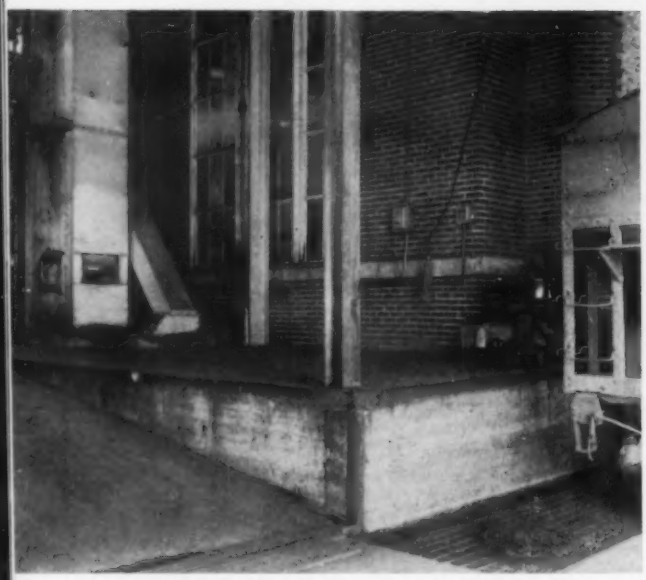
Not shown in drawing is an outdoor storage area, west of the plant and north of the railroad tracks. An overflow spout on west side of suspended bunker forms an initial pile for a drag scraper which stocks-out coal and reclaims it to skip-hoist track hopper. Yard capacity is 30,000 tons.

In designing and installing new equipment, particular attention had to be given to the necessity for keeping the plant running during changeover. Since main flight conveyors were to be installed above and to the sides of the larry rails, they were put in first. This work got under way in midsummer of 1951, when plant load was lighter than average.

At this time, new No. 3 boiler was operating and No. 4 was nearly completed. Air compressors had been removed to make way for Units 5 and 6, and erection had begun on these boilers.

The first of the overhead bunkers was put in at the east

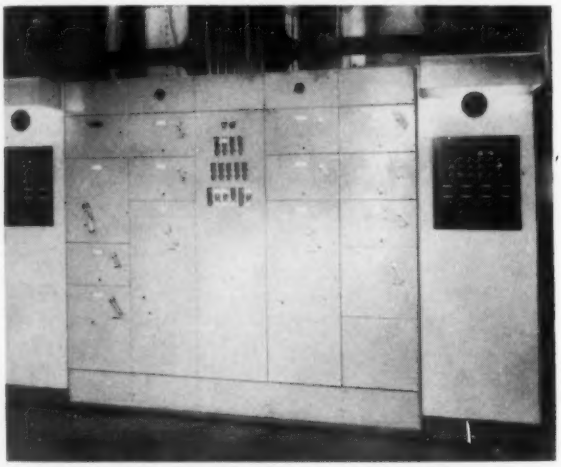




NEW UNLOADING DOCK has capstan (*right*) for positioning car over track hopper, from which a short belt conveyor with magnetic pulley feeds the bucket elevator (*left*). Just to right of elevator is chute from conveyors connecting to old bunker

FLIGHT CONVEYORS, one on each side above new hopper-bottom bunkers, draw from (1) new elevator (2) old skip hoist or (3) old bunker. Normally, all flight gates are open and bunkers are filled to the end, when a level alarm signals "stop"

FIRING AISLE below scale platform, now free of unsightly floor hoppers, is clean and roomy. Chutes leading down to pulverizers in the basement are fitted with gates and alarms



HANDLING-SYSTEM CONTROLS are centralized on this panel together with coal scale integrators. Comprehensive interlock scheme protects the equipment allowing proper sequences only

Frigidaire's coal handling is now highly flexible and reliable. Normally, all...

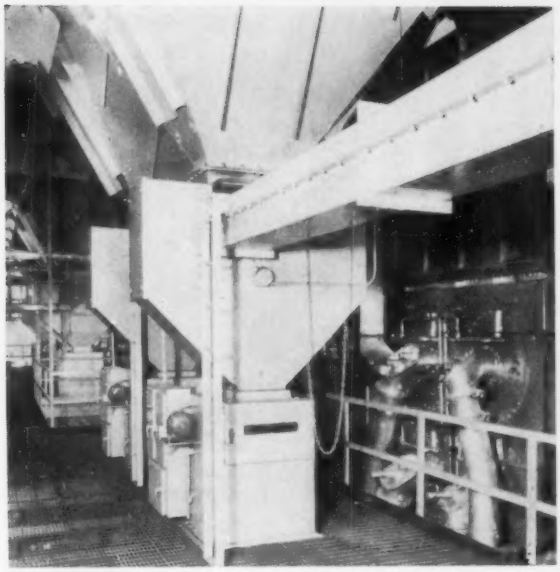
end of the plant. With temporary chutes where the scales would go in the final layout, the newly installed flight conveyors supplied Units 1 and 8, while the larry, now working on a shorter run, handled remaining boilers.

Same procedure was followed for the next two units (No. 2 and 7) and the larry travel was still further shortened. Unit 3 was next to swing over to the new system and, when it was completed, No. 4. With boilers 5 and 6 under construction, the larry could be taken out of service, and these units were cut into the new system as they became ready. When all units were changed over, the coal scales and underbunker conveyors were installed and the larry removed.

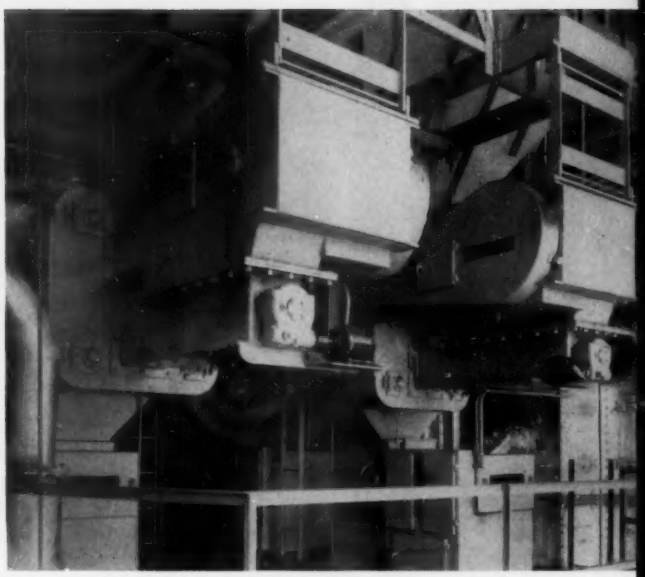
Normal operation of the present modernized system is as follows: First shift—all bunker space is filled. Second shift—needs are supplied by drawing down the boiler bunkers. Third shift—further drawdown of boiler bunkers plus supply from reserve bunker as needed.

With heavier winter loads, this general schedule is modified as follows: First shift—all bunkers filled. Second shift—extra man needed to unload coal and replenish drawdown from boiler bunkers to keep all filled. Third shift—drawdown from boiler bunkers and reserve as needed.

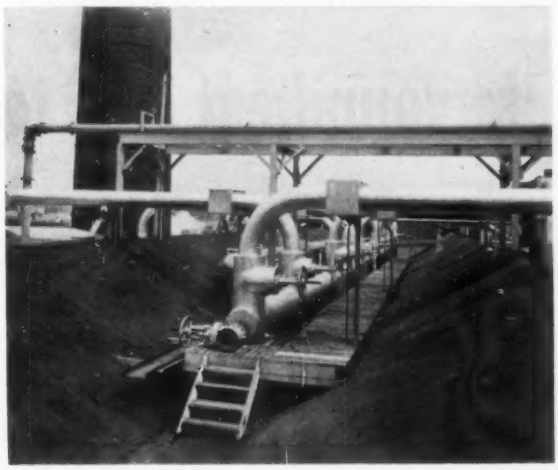
Normally, coal deliveries are scheduled to match needs as nearly as possible, so a constant outdoor storage of some



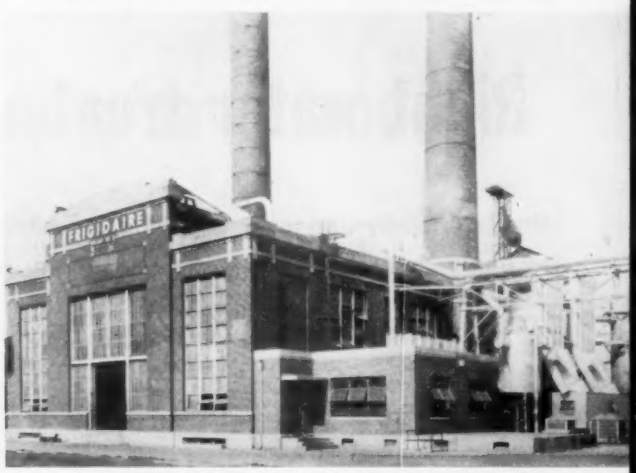
COAL SCALES normally receive coal directly from hopper outlet above, but under-bunker conveyor can shift feed from any outlet to any scale in same row. The installation is valved and controlled to give troublefree automatic operation



UNDER-BUNKER CONVEYORS, of chain-drag type, have "dribble return" at drive end. Here any coal carried past outlets on lower run drops off. A screw moves it to a small loop conveyor at right angles to main one. This returns coal to top run



MAIN-STEAM HEADER was moved outdoors to roof valley to permit full utilization of building space. Photo shows boiler leads and lines carrying steam from header to factory areas



MORE SPACE-GAINING moves were made when Units 5 and 6 were installed. Air heaters, fans for these boilers, new feedwater heater, hot lime-soda softener were put outside building

...unloading and bunker storage can be done on the day shift, reducing costs

20,000 to 24,000 tons can be kept as reserve. This reduces stocking-out and reclaiming operations and minimizes danger of storage fires. Coal is bought sized—usually 2x0 or 1½x0 in.—and no crusher is installed. Each of the coal-elevating systems from the track hoppers is equipped with a magnetic pulley to segregate tramp iron.

Another interesting feature of the modernization at the Frigidaire boiler plant was the solution of some tight space problems. After the first three of the present units (No. 1, 2 and 8) were installed, need for maximum boiler capacity in limited space led to a variety of building modifications.

To fit in No. 7 boiler, some roof changes were needed and the tubular air heater and fans were put alongside the unit in front of the existing stack. To make this possible, and to facilitate later installations, the main steam header was put in the valley of the roof (*see photo above*). Lines carrying steam to various production areas take off the header in the vicinity of Unit No. 7, going north across a roadway on an elevated structure. Other lines take off at the extreme northeast corner and go under the road in a utilities tunnel.

When Units 3 and 4 were installed, air heaters were fitted in alongside, but fans, etc, were put in a penthouse on the roof. Space limitations were even tighter on No. 5 and 6, and air heaters, fans, etc, were placed outdoors (*photo*).

DELIGNIFICATION is one of the basic water-treatment problems. This old tower's breakdown is in advanced stage

Right water treatment: your best bet to

Here's a step-by-step review showing you when, where and how to apply chemicals for the control of water in cooling towers

By **JACK M SLOUGH**, *Rating & Design Engineer, Santa Fe Tank & Tower Co*

► LIFE EXPECTANCY of a cooling tower is 20 years, or more, with good water treatment. But without proper treatment and suitable makeup, life can be reduced to only five years. Since tower cost may equal or exceed the cost of any other single unit in its circuit, it is easy to see how important correct water treatment can be.

Types of Fouling. The four basic problems in any cooling-water system —open or closed—are:

1. Scale and deposit formation on heating surfaces that reduces heat-transfer rates and increases pumping heads.
2. Delignification, or the structural breakdown of tower wood.
3. Corrosion in tower and units it serves.
4. Algae and slime, which reduce performance, promote corrosion and foul connected equipment.

All four problems are interrelated and the correction of one may promote another. No single treatment solves all. Delignification and corrosion bring on the most expensive destruction, but algae and scale cause a greater efficiency loss.

Makeup. Amount of water that must be added to a tower is important because the makeup is the source of impurities entering the cooling system. For each 10-F difference of the water passing through the tower, makeup is about 1% of the water circulated. For example, in a tower circulating 2500 gpm with a 15-F temperature difference, makeup is $15/10 \times 2500 \times 0.01 = 37.5$ gpm. Though this rule is suitable for most estimates, the tower manufacturer can supply extremely accurate figures on makeup at given cooling loads.

In addition to makeup for evaporation, the water loss due to the wind or air stream must be replaced. Typical windage losses, based on circulation rate, run 1 to 5% for spray ponds, 0.3 to 1% for atmospheric towers, and 0.1 to 0.3% for mechanical-draft towers. With a mechanical-draft tower in the above example and a windage loss of 0.2%, $2500 \times 0.002 = 5$ gpm; total makeup $= 37.5 + 5 = 42.5$ gpm.

Recommended blowdown rates are given in the table below.

Makeup bicarbonate hardness as ppm. $CaCO_3$	*Blowdown*
0-103	½ × evaporation
103-206	1 × evaporation
206-291	2 × evaporation
291-394	4 × evaporation
394-496	7 × evaporation
496-548	10 × evaporation

Scale and Deposits. Calcium carbonate is the most common scale met in once-through and recirculating systems, but silicate and sulfate scales, or only sulfate, sometimes form in recirculating systems. But the two latter scales are only of minor importance if a few relatively simple steps are taken to avoid exceeding the solubility of calcium and magnesium silicates and calcium sulfates.

Most water treatments for scale prevention add some chemical to raise the solubility curve an appreciable amount so high concentrations of carbonates will

4 basic problems to meet in cooling-tower water treatment

1 Scale control

a. *Sodium hexametaphosphate:* Maintain 2 ppm residual. Add initial charge of 4 lb per gpm makeup. Use acid to hold right pH

b. *Beta glucoside:* Add 10 ppm to makeup. This chemical is also good corrosion inhibitor

c. *Tetra phosphoglucosate:* Maintain 2 ppm residual. Easy to use, keeps indefinitely

d. *Lime and soda ash:* Should not be applied except by well-qualified water chemist

e. *Zeolite:* Try one cubic foot of zeolite to treat 2000 gallons of makeup. The acid treatment is recommended

2 Delignification control

a. *pH and sodium carbonate:* Control these two factors as detailed in the text of this article. Hold pH of water at 7.0

b. *Sodium zeolite treatment:* Regulate blowdown to keep sodium carbonate less than 1000 ppm

3 Corrosion control

a. *Chromglucosate:* Maintain 100 ppm residual

b. *Sodium chromate:* Maintain 25 to 100 ppm residual

c. *Sulfoglucosate:* Maintain 2 ppm residual. Inhibits oxygen corrosion

4 Algae and slime control

a. *Chlorine:* Maintain about 2 ppm residual

b. *Sodium hypochlorite:* Maintain at about 10 ppm. This material is safe, easily used

c. *Potassium permanganate:* Use 2 to 5 lb per million gal water. Rate depends on blowdown

NOTE: See the text for additional data on each of these water treatments

extend cooling-tower life, save money

remain in solution. Other treatments reduce the concentration of carbonate in the makeup, or change the chemical structure of the carbonate.

Controlling Scale. Reports from industry show that a number of methods are in regular use for controlling scale in cooling-tower systems. Study of these reports indicates that results vary from one plant to another, and in different localities. So it is difficult to prescribe any one treatment good for all plants in all parts of the country.

Threshold treatment using sodium hexametaphosphate to increase the solubility of carbonate hardness is popular. Where concentration of scale-forming salts is high, continuous blowdown is often used to supplement the water treatment. Sodium hexametaphosphate should not be expected to remove old scale because this is usually hard and redissolves slowly.

Organic chemicals like beta glucoside and the compounds of glucosates are receiving more attention as scale controllers and corrosion inhibitors. A few reports from industry show marked tendencies toward scale prevention and removal. Beta glucoside is a greenish-brown, viscous semisolid, which is difficult to dissolve. It should not be stored for long periods because it will ferment.

Tetra phosphoglucosate is easier to use because it dissolves readily, keeps indefinitely and is nontoxic. But some reports show its scale preventive characteristics are not as great as beta glucoside. These same reports recommend treating makeup water with 12 ppm of the beta, or about 2 ppm of the tetra.

Complete removal of objectionable compounds from cooling-tower makeup before the water enters the circuit provides scale control. However, complete removal is often difficult and in general is uneconomical.

Lime and soda ash, while successful, are difficult to apply unless there is an experienced operator on hand. Using too much of either is almost as bad as no treatment. Insufficient amounts can leave residual hardness. When applied cold, these chemicals react very slowly, leading to further difficulties.

Zeolite treatment, well known for other applications, finds use in cooling systems. Because zeolite treatment may impart a high sodium alkalinity to the water, it may be necessary to add sulfuric acid to reduce the alkalinity.

Sulfuric-acid treatment is often recommended for preventing carbonate scales. Expensive mechanical equipment is unnecessary. Normally the treated water is more corrosive than the original raw water. Careful control of concentration is required to prevent sulfate scaling.

Delignification is the removal of alkali or bisulfite soluble matter from wood, leaving a weak stringy mass, worthless for any part of a cooling tower. High pH of cooling-tower water leads to removal of lignin from tower wood, leaving only the cellulose to bind the wood cells.

Tests show that high pH is not the only factor contributing to delignification. Sodium bicarbonate changes to the carbonate form when pH exceeds about 8.5. Keeping pH below 8.5 tends to nullify most types of delignification and scale in cooling towers.

Sodium-zeolite treatment of carbonate hard water may lead to high concentrations of sodium carbonate. Under these conditions, close control of pH is imperative. Where sulfuric acid is used to treat makeup, pH may drop to as low as 3. Low pH is less harmful to wood than high pH, but the situation is reversed for metal parts like piping, condensers, etc.

Experience shows that high chlorine

(*Continued on page* 232)

EXTERIOR VIEW of Ponca City's well-known municipal diesel plant. The new section of the plant is on the right end of building

Ponca City diesel plant boosts its

Already notable for its size, Ponca City, Okla., municipal diesel plant is now . . .

- **Bettering its own records**
- **Improving dual-fuel output**
- **Paring pilot-oil needs**
- **Maintaining economy despite rising operating costs**
- **Serving its greatest load**

By **PAT SCHLESINGER**, Superintendent
Ponca City Water and Light Department

► OUR NEWEST ENGINE is a 4275-hp Nordberg gas-burning diesel. Addition of this unit raises plant capacity to 16,275 hp. With the new engine on the line, total output reached 37,877,350 kwhr, a gain of about five million kwhr over the previous year.

Economies. To understand our operation, a few details about our present engines will be helpful. For the fiscal year ended June 30, 1953, our four Nordberg dual-fuel engines produced 36,537,650 kwhr. Fuel consumption for these engines in this period was 371,139,000 cu ft of natural gas and 145,439 gal of pilot oil. This is an average of 10.15 cu ft of gas and 0.0039 gal of oil per kwhr.

We pared pilot-oil consumption to a scant 5.2% of the total heat value of the fuel, while holding gas consumption to the level of previous years.

Rising costs have made economy an even more difficult goal. Our largest single item of operating expense is fuel. And it is here that rising prices have had most effect. We paid 15c per mcf of natural gas during the four winter months, and a low of 12.5c for the other eight months of the year. However, gas price was raised to a flat 15c, while the 28 gravity fuel for pilot oil remained at 8.5c per gal.

At these prices the four gas-burning diesels produced electrical power at a total cost of 1.85 mills per kwhr. Of this total, gas cost 1.52 mills, pilot oil 0.33 mills per kwhr.

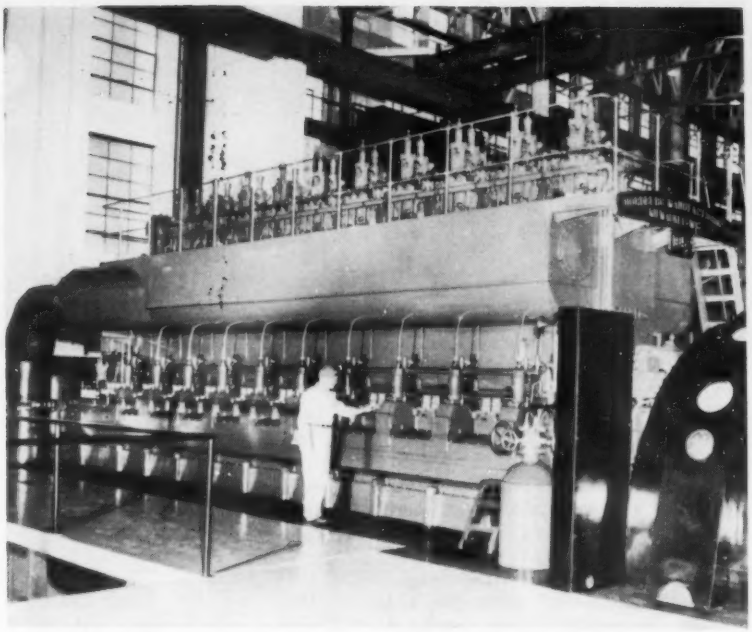
Plant Loads. Despite every effort to predict load growth well in advance of actual demand, we've had to use all our ingenuity and operating skill to keep up with the rising consumption of electricity. The oil refineries, which are our city's principal industry, have rapidly expanded in size, production and labor.

New manufacturing plants have come to town to make oil-field bits and other equipment for the growing oil-industry market. Not only has population climbed to 21,000, but the per capita consumption of electricity has also risen sharply.

One reason for this trend is that the refineries employ men with high professional or mechanical skills and pay correspondingly high salaries. These men can afford to participate in the nationwide trend toward greater use of electrical appliances. During a hot spell in July 1952, new air conditioners went on the line at the rate of a dozen a day. Peak loads rose 3000 kw in five years from 4300 kw in 1946 to 7300 kw in 1951. In 1952, peak reached 8300 kw.

Peaking Capacity. To carry the peaks, every engine in the plant was put on the line and overloaded. During part of the time we were running overloaded, our new 4275-hp engine was being installed. It went on the line July 8, 1952. For the remaining 51 weeks of the fiscal year it operated more than 95% of the time, running up a total of 8163 engine hours and producing 17,241,050 kwhr.

When operating at about two-thirds



LATEST dual-fuel diesel produced 17,241,050 kwhr in first year of operation

Equipment serving new engine

Engine	4275-hp 10-cyl 21½x31-in. 225-rpm Duafuel engine, Nordberg Mfg Co
Generator	General Electric Co
Governor	Woodward Governor Co
Blower	Allis-Chalmers Mfg Co
Air filter	Dollinger Corp
Lube Oil	Continental Oil Co
Cylinder lubricators	Manzel Bros Co
Lube purifier	Honan-Crane Corp
Lube-oil cooler	Kewanee-Ross Corp
Auxiliary lube pump	DeLaval Steam Turbine Co
Lube-transfer pump	Haight Co
Lube strainer	Nordberg Mfg Co
Cooling-water pump	Allis-Chalmers Mfg Co
Water-transfer pump	Berkeley Pump Co
Heat exchanger	Kewanee-Ross Corp
Fuel oil	Continental Oil Co
Fuel filter	Wm W Nugent & Co, Inc
Fuel-injection pumps	American Bosch Corp
Natural gas	Northern Okla. Gas Co
Exhaust silencer	Maxim Silencer Co
Thermometers	Electric Auto-Lite Co
Gage panel	Nordberg Mfg Co
Exhaust pyrometer	Illinois Testing Laboratories, Inc.
Gages	J E Lonergan Co
Switchboard	General Electric Co

output and efficiency

load, the new unit produced a kwhr at a fuel cost of 1.85 mills, consuming 10.35 cu ft of gas and 0.0035 gal of pilot oil. With an average load of over 70% for March 1953, the engine's fuel consumption was cut to 9.93 cu ft of gas and 0.0033 gal of pilot oil.

Engine Details. The new Nordberg dual-fuel engine is a 10-cyl 2-cycle 21½x31-in. 4275-hp 225-rpm unit, direct connected to a 3040-kw 3-ph 60-cps 13,000-v generator.

Operation. Lube-oil consumption is low. Cylinders required 4149 gal of detergent oil fed from individual forced-feed lubricators. Crankcase took 1428 gal of straight mineral oil. Combined, this gives 6257 hphr per gal of lube oil.

The lube oil runs clean and it has been necessary to change the fuller's earth filtration material only once after seven months of operation. Oil is periodically analyzed to determine its acidity. If necessary, the oil can be centrifuged, washed with water, and heated to remove moisture.

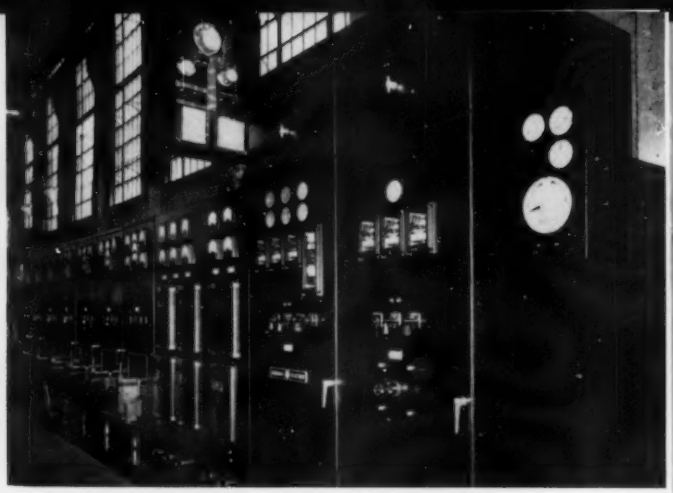
Cooling. The cooling-water system serving the new engine is interesting, and provides dual advantages of reducing auxiliary power requirements and affording emergency protection.

A motor-driven centrifugal pump circulates soft water through the engine jackets and a heat exchanger. Floating on the suction of this pump is a slender 30-ft-high vertical tank. The tank pro-

Table I: Plant Performance—July 1952 through June 1953

	Kwhr generated			Fuel oil consumed, gal.			Gas consumed, mcf		Lube oil, No. 7		
	No. 7 engine	All gas units	Total plant	No. 7 engine	All gas units	Heavy fuel	No. 7 engine	All gas units	Crank-case	Cyl	Hr run No. 7
1952											
July	817,600	3,246,300	3,556,700	2,770	14,080	36,000	9,162	36,482	100	391	486
Aug	1,504,800	3,496,200	3,714,100	5,800	15,150	24,442	16,842	39,122	180	345	736
Sept	1,356,000	2,904,200	3,018,200	5,180	11,859	9,765	15,162	32,512	160	358	688
Oct	1,335,700	2,889,200	2,933,900	4,980	11,675	4,675	14,100	30,501	140	349	669
Nov	1,351,500	2,831,200	2,875,200	5,060	11,190	4,600	13,770	28,806	150	350	693
Dec	1,519,000	3,101,300	3,116,200	6,015	13,345	1,400	15,500	31,644	78	485	744
1953											
Jan	1,436,650	2,961,770	3,060,270	5,300	12,024	9,400	14,260	29,415	55	300	667
Feb	1,552,100	2,565,880	2,678,680	5,538	10,602	9,600	15,077	24,927	155	348	666
Mar	1,636,300	2,837,900	2,887,500	5,489	10,549	3,198	16,250	28,181	50	352	722
Apr	1,569,650	2,795,050	2,799,250	5,040	10,376	1,014	15,820	28,160	115	282	702
May	1,498,280	3,075,240	3,114,740	4,610	10,198	4,372	15,515	31,887	35	339	670
June	1,663,470	3,833,410	4,113,610	5,568	14,468	27,800	17,152	39,502	210	350	720
Total	17,241,050	36,537,650	37,877,350	60,350	145,439	136,266	178,610	371,139	1,428	4,149	8,163

ANOTHER VIEW of new engine shows some of its auxiliaries



TWO PANELS are added to switchboard to serve the new engine

vides a static pressure of about 10 psi. Total pressure in the system when pump is running is 18 psi. Head provided by the tank reduces the amount of power required to circulate the cooling water.

Use of the storage tank permits the system to operate as a thermal siphon. Should a pump fail, the system can continue to provide adequate cooling for about 10 minutes. Makeup needs for this system are small, and water temperature remains constant under variable load conditions.

Maintenance. Careful periodic inspections and preventive maintenance are an integral part of Ponca City's operation. By removing the 4-in. inspection plates in the exhaust header at each cylinder of the new engine, it is possible to inspect the pistons, rings and intake ports. Using this procedure, all 10 cylinders can be checked in half an hour. Since this unit went into service there have been no shutdowns caused by engine failure.

Costs. Tables I and II summarize operating costs for the new engine and for the entire plant during the fiscal year ending June 30, 1953. With a total production expense of $214,393.22, average cost of producing a kwhr is 5.75 mills. Net profit of the light department was $678,480.08, for the year of 1952-53.

Table, *right*, shows the light department of this municipal plant has been consistently and increasingly profitable.

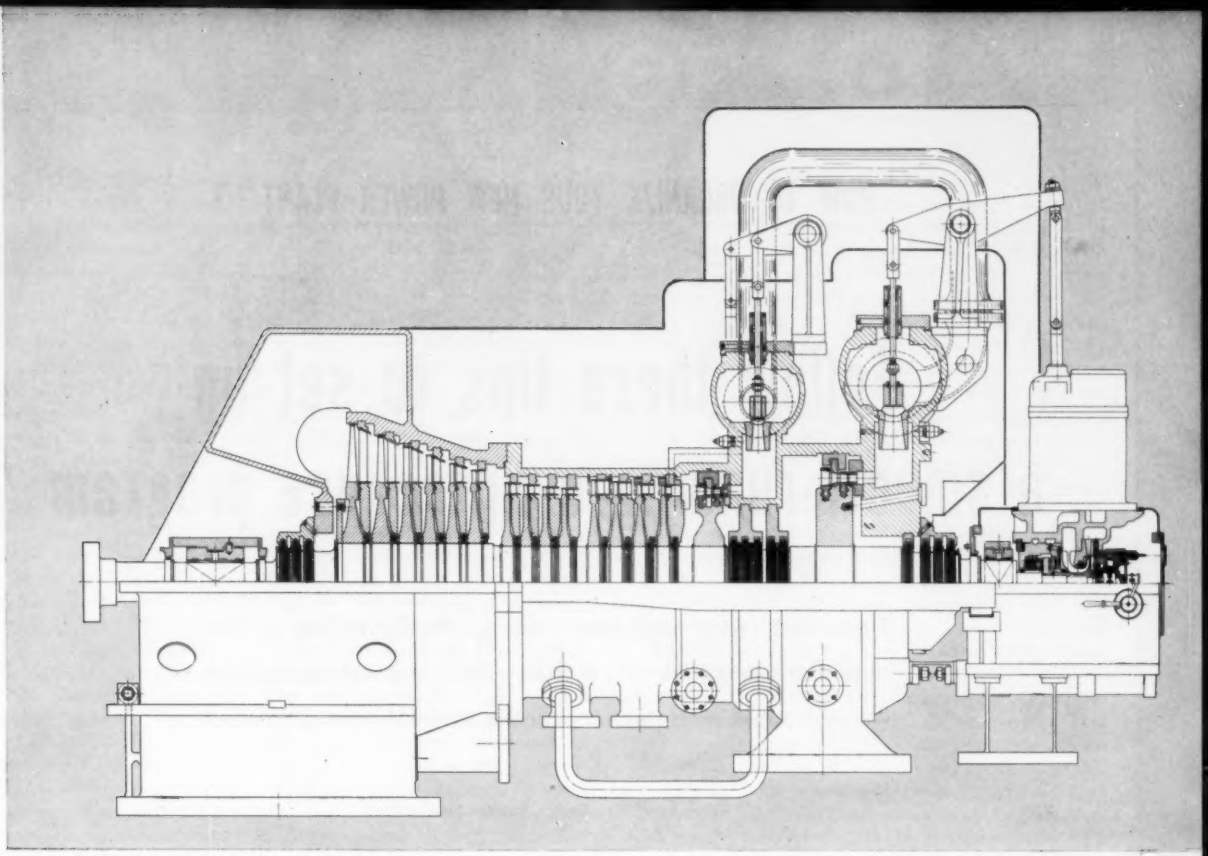
Earnings have been sufficient to finance all plant expansion, all other civic improvements, including an airport and library. In addition, they have paid for almost all costs of local government. Ponca City has been a taxfree community for the past 20 years.

Year	*Net Profit*
1944	$283,647.31
1945	294,964.41
1946	311,903.49
1947	342,826.90
1948	388,873.83
1949	463,850.95
1950	551,843.49
1951	560,080.25
1952	622,459.36
1953	678,480.08
10-year total	$4,498,930.07

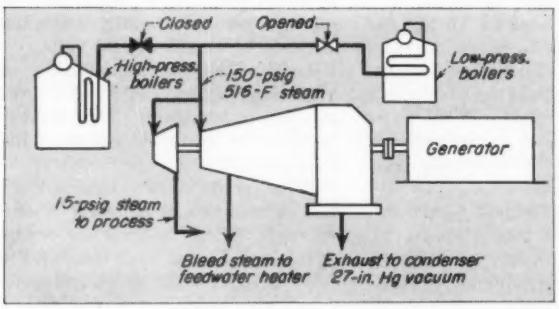
Ponca City's record is by no means a closed book. Right now we are busy installing a new Nordberg 5135-hp dual-fuel engine. We are confident it will be another step toward greater economy.

Table II: Operating Statement of Light Department, June 30, 1953

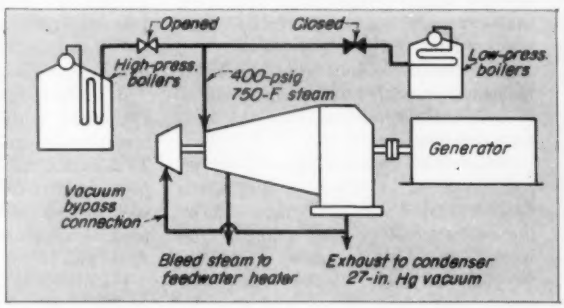
Operating income	
Commercial lighting	$ 275,547.70
Commercial and industrial power	185,363.89
Residential lighting	551,792.87
Street and white-way lighting	6,978.00
Electric current for pumping	30,549.00
Penalties	3,303.42
Miscellaneous	6,394.83
Interest on daily balances	630.00
	$1,060,379.71
Operating expenses, production	
Salaries, office	$ 120.00
Salaries, light plant	53,717.11
Renewals and repairs (plant, equipment)	6,832.31
Plant supplies	2,634.41
Insurance	12,438.96
Depreciation	39,307.18
Water, light and heat	4,789.72
Fuel	75,133.81
Lubricating and cylinder oil	5,613.24
Engine maintenance	13,806.48
Total production expense	$ 214,393.22
Operating expenses, distribution	
Salaries, office	$ 10,898.62
Salaries, meter readers, linemen	60,127.97
Renewals and repairs (lines, etc.)	15,146.67
Stationery and office supplies	2,046.27
Postage, telephone and telegraph	2,294.96
Insurance	4,035.23
Depreciation	33,718.35
Oil, gas and upkeep of cars	3,585.73
Renewals and repairs (meters)	2,627.59
Total distribution expense	$ 134,481.39
Total operating expense	348,874.61
Net operating income	$ 711,505.10
Financial expense	
Deduct: Interest on electrical deposits	$ 1,385.25
Interest on electrical bonds	13,992.50
Nonoperating expense and taxes	17,647.27
Total deductions	$ 33,025.02
Net profit	$ 678,480.08
Net kwhr produced	37,271,440



DUAL-PRESSURE AUTOMATIC-EXTRACTION steam turbine operates on two different cycles, depending on load requirement . . .



PROCESS cycle operates four months a year. It receives steam at 150 psi and supplies 15-psi steam and electric power



NONPROCESS cycle operates eight months a year. Steam from boilers is 400 psi. This setup supplies power only

Versatile Turbine Boasts Unique Operation

By W T MANNING, *Manager*
Industrial Turbine Engineering
Westinghouse Electric Corp

► THE SPECIAL REQUIREMENTS of industrial processes have led steam-turbine manufacturers to produce some unusual units. Recently a dual-pressure automatic-extraction turbine was built that is unique in both its operation and control arrangements.

The process plant that this turbine serves operates only four months a year. During this period the plant supplies electricity and steam to process, and also supplies the community with electrical power. For the remainder of the year only the community power load exists. High-cost crude oil is used during the latter period and high efficiency is a must. The turbine, therefore, operates on two seasonal cycles shown in the flow diagram.

Operation. The unit is actually two turbines in one cylinder, with interconnected steam chests. During the process season, steam supply is from low-pressure boilers at 150 psi. It enters both the single-stage impulse turbine (nearest the governor) and the multistage impulse turbine. All the 150-psi steam that passes through the single-stage turbine exhausts at 15 psi and goes to process. Steam passing through the multistage turbine condenses at 27-

(*Continued on page* 244)

HOW TO ORGANIZE YOUR NEW POWER PLANT—7

Follow these tips to set up a smooth-running maintenance program

Time, dirt, wear and tear may gradually reduce a fine new plant to a junk pile if their effects are not combatted. Avoid trouble with this serviceable maintenance procedure

By D C SWIFT, *Ebasco Services Incorporated*

► THE ELEMENTS of a sound maintenance program include inspection, crew, tools, repair parts, materials, leak checks, trouble reports, preventive and regular maintenance, records. These elements, properly handled and adapted to your plant conditions, form the basis for smooth operation.

Inspection. Unless a plant is specifically intended for a limited life, take a long-term view of maintenance. Keep the entire plant in good shape if you want it to remain in active service for 30 years or more. Make repairs for keeps whenever possible, and thus reduce the number of things continually coming up for attention.

Inspect and maintain equipment on a schedule of minimum outage time to reduce operating losses. This requires careful planning and closely supervised execution so you'll have material and tools where you need them. Work carefully done avoids leaks, forgotten parts or other "bugs" that may cause either delays in resuming operation or later outages.

Often the expense of maintenance and of operating labor are almost equal, while total maintenance cost is usually about equally divided between labor and material. You can sometimes reduce maintenance costs through changes in operation, equipment design or material. Keep a watchful eye for "sore spots" to improve reliability, cut costs.

Carry on maintenance with minimum interference with plant operation. Obtain clearance for work on all apparatus and place scaffolds, hoists and tools to cause the least obstruction possible.

After completing repairs, leave a unit clean and ready to run, with all maintenance material and tools removed. Then turn it back to the operators, leaving a maintenance man standing by. He sees to any necessary bolt tightening, packing adjustments, leak stoppage, etc, while unit is put back into operation.

Maintenance Crew. Number of maintenance men for a power plant is roughly determined by amount and type of its equipment. Type of fuel, circulating-water facilities, and availability of outside contractors also have an important bearing on the maintenance crew required. This may vary from one man for each 2 mw to a minimum of perhaps one man for each 10 mw of installed capacity.

Where there are a number of plants in a system, maintenance men can move from one plant to another to take care of major overhaul work loads. In the smallest plants, operators may do their own repair work with occasional help from outside specialists.

As a plant grows, the maintenance force normally divides into electrical and mechanical groups. The mechanical men may subdivide into groups specializing in boiler work, pipe work, brickwork and insulation, welding, machine work, painting. The electricals may subdivide into transformer, motor, lighting, switchgear and control units.

Avoid excessive specialization, and train men so they can handle several lines of maintenance. This makes it easier to lay out work and gives them more variety.

Skilled crafts usually require a foreman or subforeman for every seven to ten men. Where laborers are engaged in routine physical work requiring little or no supervision, number of men in a crew may be increased.

Shop Facilities, Tools. In the smallest plants, a work bench and vise with a fair complement of hand tools may suffice. As a plant grows, larger shop areas and more complete tooling are required. Finally, there may be transformer repair, motor repair, general electrical maintenance, also pipe, welding, blacksmith, carpenter, instrument and machine shops, etc. If possible, these shops should be centrally located and grouped for convenient access to the plant and store rooms.

The medium-sized plant's shop equipment might include small- and medium-sized lathes, power drill press, shaper, metal saw, pipe threading machine, hydraulic press, and gas and electric welding outfits.

Where a plant has access to commercial facilities for handling large-size

work, it is more economical to send out the small amount of this type repair than to tie up considerable money and space for seldom-used tools.

The company usually supplies special tools, like large pipe wrenches, impact wrenches, tube rollers, turbine bolt wrenches, slings, chains, hoists, mauls, axes, pipe cutters and dies, drills and taps, electric or air drills, meggers, test electrical sets, conduit benders, as well as extension cords, clean-up tools, paint brushes, scrapers and the like.

More personal tools like pliers, screwdrivers, small wrenches, hammers, micrometers, calipers, depth gages, etc, may be supplied either by the company or the employe. The majority of plants furnish a few tools or replace the employe's lost or broken tools.

Larger plants usually set up a central tool room. A maintenance man has a set of numbered checks that he exchanges for tools. Thus, if a tool is not in stock, the check identifies the man who has it. The tool-room man usually maintains tools in a safe and operable condition, thus reducing accidents and delays.

Repair Parts, Materials. Unless your plant is near a large city where repair parts and materials are always available, keep a stock of essential parts on hand. Although the usual standard parts like bearings, packing, bolts and nuts are obtained quickly, some special parts are not readily available.

If you stock the spare parts the manufacturer recommends for each piece of equipment, you largely eliminate delays while awaiting replacement parts. Experience will point out additional items to keep on hand.

Store spare parts where they will not deteriorate and where they can be found. Keep a perpetual inventory of parts, and plainly tag each one with order number, description and plant unit. Even if misplaced it can then be identified and restocked.

Avoid stocking duplicate parts. Ball bearings, for example, are often interchangeable even though different manufacturers use different numbering systems. Parts for similar but not identical machines can often be substituted for each other. This saves money otherwise tied up in idle stock, or permits a better reserve of parts.

For maintenance work you need a supply of smaller pipe fittings: valves, packing, gaskets and gasket materials, pipe dope, shellac, cutting oil, nuts, bolts, screws, nails, rope, chain, wiping rags, tape, copper wire, cleaning fluid, insulating varnish, paint, refractory cement, welding and brazing supplies, etc. Designate someone to see that these stocks stay at desired levels.

Leak checks made daily often point out incipient trouble. Leaks not only indicate potential operating difficulties, but they also make a mess in the plant, cause waste, and may be dangerous to personnel. Generally the leak-check man can make needed repairs on his rounds. Where special maintenance or an equipment outage is required, the leak-check man writes up a trouble order for the repair.

Trouble-report sheets or cards expedite repairs of leaks or equipment operating improperly, and show need for special repair or inspection. The operator noticing the trouble writes up briefly the location and story of the trouble. Plant superintendent or his assistant collects reports and assigns them to the maintenance supervisor or mechanic who handles the type of work that is apparently necessary.

Trouble-report sheets are sometimes made out in duplicate so both maintenance man and his supervisor have a copy. By marking his copy with name of man handling the repair, the supervisor has a follow-up reminder that helps him assign work evenly.

Mechanic notes the repair made and turns the report back to his foreman on completion. Finished trouble reports can be filed as a reference check list or discarded as soon as the repair is reported done.

Preventive Maintenance. Make routine inspections of all equipment that is subject to wear, misalignment, deterioration or failure, or that needs periodic testing or adjustment to assure that it is in proper working order. Prepare chart or tabular schedules showing when to inspect each item.

If schedule is in chart form, plant operating supervisors can note the inspections coming due and make out trouble reports or inspection requests. They then check off completed items on the chart.

If schedule is tabular, a record clerk will usually make out an inspection request and file results under the particular unit of equipment.

Other systems note date of inspection and use a special equipment history form for recording significant data only.

Proper scheduling of preventive-maintenance inspections avoids making them too often, but catches incipient troubles before they cause a serious outage or major equipment damage. Although preventive maintenance requires a good deal of follow-up and clerical work, experience shows that total costs are reduced and plant reliability improved.

Regular Maintenance. In general, inspect boilers and most of their auxiliaries once or twice a year. Turbine-generators need inspection after the first year of operation and generally every two to four years thereafter.

When a turbine-generator is opened for inspection, plan the dismantling and assembling operations carefully to speed the job. Assemble all necessary tools, slings, blocking and anticipated spare parts before the machine is shut down. Remove outer casing, dismantle some governor parts and necessary connecting piping and purge hydrogen-cooled units while the machine is cooling down. You can remove turning gear after unit has partially cooled, since temporary bowing will have no effect on a dismantled machine.

Remove bolts in the correct order, and use a crane for lifting heavy parts. Diagrams of sling arrangements and lift dimensions help speed operations. Assign a spot with the necessary blocking for each piece of the machine, considering floor strength and convenience for cleaning blades, etc.

Carefully tag wires removed or disconnected so there is no question of electrical connection during assembly. Note settings and adjustments so they can be reproduced. Put bolts and other parts in convenient, separate boxes and protect delicate parts from damage.

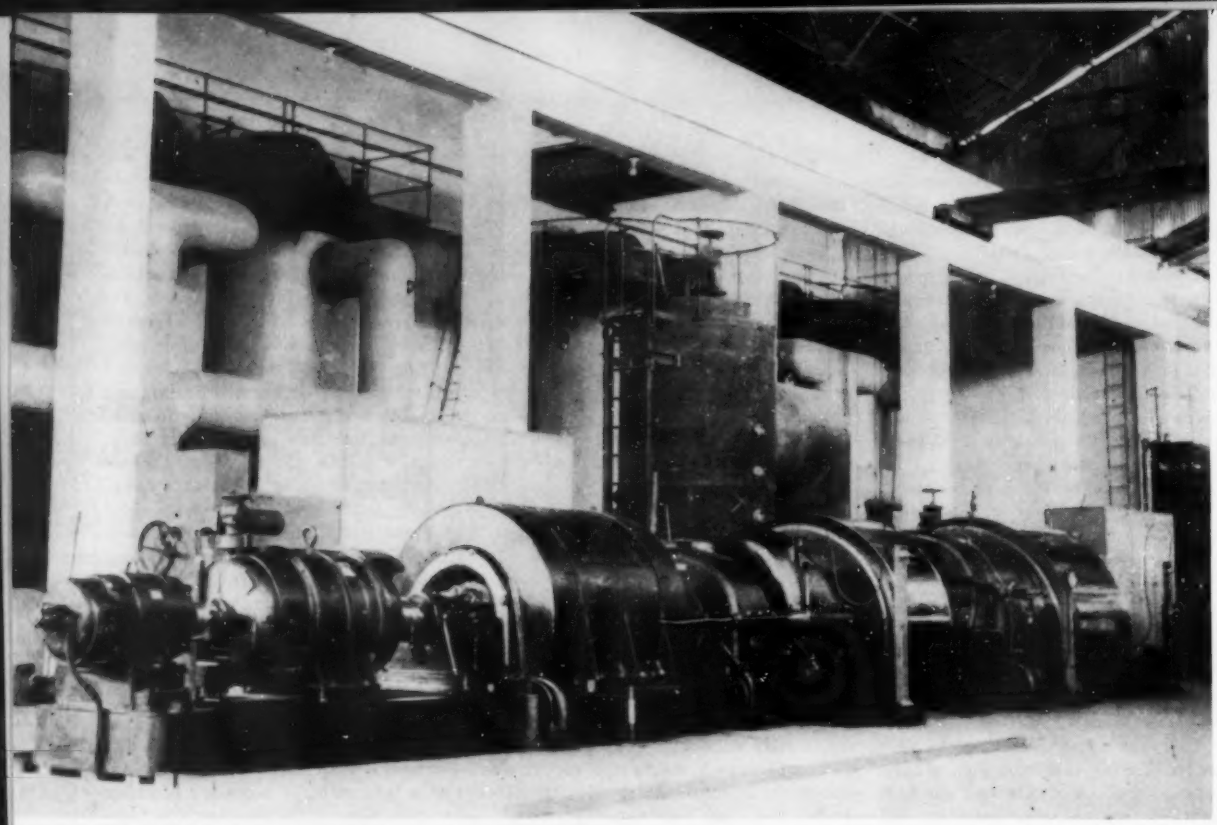
Inspect each part as it is removed, noting its condition. Check machine clearances, evidences of steam or water cutting, deterioration or cracking of metal, etc. Note changes in bearing clearances, wear of seals and packings. Often a photograph effectively shows condition that is difficult to describe in words. Following inspection, clean all parts and put in as good condition as possible, or renew them.

After cleaning, many plants subject turbine rotors to kerosene and whitewash inspection or a Magnaflux examination to assure that no cracks have developed. Small dents on turbine blading can usually be straightened out safely.

Where plant men have gained experience, they should direct and handle the work of dismantling and assembly, with a factory engineer acting as consultant and adviser. Plant men become more familiar with and adept at working on their own machines than an engineer who handles a variety of machines in different plants.

But this knowledge and familiarity

(*Continued on page* 238)



ONE OF TWO 1650-kw open-cycle gas turbines with regenerators. These units burn 60% bunker-C oil mixed with 40% diesel oil

Over 30,000 hours experience on high-ash fuel oil shows...

Gas-turbine maintenance cost is low

► Two 1650-KW Brown Boveri gas turbines have operated over 3½ years at the Pertigalete Cement Works in Venezuela. These turbines have supplied the sole source of power in this plant until recently, and they have totaled well over 30,000 operating hours. From this background, we can get some definite information on maintenance needs, costs.

The units have a single compressor and turbine on the drive shaft, regenerator and single combustion chamber. Over-all efficiency is 21% with 95-F intake air temperature. Turbine inlet gas temperature is 1110 F. Power shaft turns 1800 rpm, geared from turbine speed of 5350 rpm. Pressure ratio of compressor is 3.0.

Maintenance required is as follows:

Turbines. Oil burned in these units is a mixture of 60% Venezuelan bunker C and 40% diesel oil. This has high ash content with high proportion of vanadium and sodium, making ash deposits on the turbine blades unavoidable. Deposits are washed out every 900 hours by a simple and effective method. After the turbine cools to a prescribed temperature, a built-in washing device injects water on the blades while the turbine is turned by the starting motor. Washing takes one or two hours, after which unit returns to service at once.

This method cleans the turbine thoroughly in spite of the large proportion of insoluble ash. Since the turbine gas-inlet temperature does not exceed 1200 F, the turbine blades remain free from corrosion.

Regenerators. Built-in soot blowers that take compressed air from the gas turbine clean regenerators in service.

Compressors. In spite of air filters installed, a certain amount of cement dust builds up in the compressor. This accumulation is washed out about every 3000 hours.

Fuel jets. These are changed every 3500 hours. The jet that has been removed is inspected, and eroded parts replaced so the jet can be used again.

Combustion-chamber lining. Heavy fuel causes a certain amount of wear in the combustion chamber. There are 250 easily removable elements making up the inner flame-resisting wall of the combustion chamber, and these elements must be checked periodically and changed when required. Experience has shown that one complete set of elements will last many years.

Maintenance Costs. Lubricating oil has been used over 18,000 hours and is still in perfect condition. This practically eliminates lube oil as a cost item.

Other than a few combustion-chamber elements and eroded liners in fuel jets, no parts have needed replacing. This amounts to an extremely low cost of spare parts per kilowatt-hour.

Data in this article are taken from the May/June 1953 issue of the *Brown Boveri Review.* Additional data on operation of other Brown Boveri gas-turbines are given in that issue.

Power's DATA SHEET

No. 263

Temp, F → / ↓	0	1	2	3	4	5	6	7	8	9
0	1.0297	1.0292	1.0287	1.0283	1.0278	1.0273	1.0268	1.0263	1.0258	1.0253
10	1.0248	1.0243	1.0238	1.0233	1.0228	1.0223	1.0218	1.0213	1.0208	1.0203
20	1.0198	1.0193	1.0188	1.0184	1.0179	1.0174	1.0169	1.0164	1.0159	1.0154
30	1.0149	1.0144	1.0139	1.0134	1.0129	1.0124	1.0119	1.0114	1.0109	1.0104
40	1.0099	1.0094	1.0089	1.0084	1.0079	1.0074	1.0069	1.0064	1.0059	1.0054
50	1.0049	1.0044	1.0039	1.0035	1.0030	1.0025	1.0020	1.0015	1.0010	1.0005
60	1.0000	0.9995	0.9990	0.9985	0.9980	0.9975	0.9970	0.9965	0.9961	0.9956
70	0.9951	0.9946	0.9941	0.9935	0.9930	0.9925	0.9920	0.9915	0.9911	0.9906
80	0.9901	0.9896	0.9891	0.9886	0.9881	0.9876	0.9871	0.9866	0.9861	0.9856
90	0.9851	0.9846	0.9841	0.9836	0.9831	0.9826	0.9821	0.9816	0.9812	0.9807
100	0.9802	0.9797	0.9792	0.9786	0.9781	0.9776	0.9771	0.9766	0.9762	0.9757
110	0.9752	0.9748	0.9743	0.9738	0.9733	0.9728	0.9723	0.9718	0.9713	0.9708
120	0.9703	0.9698	0.9693	0.9688	0.9683	0.9678	0.9673	0.9668	0.9663	0.9658
130	0.9654	0.9649	0.9644	0.9639	0.9634	0.9629	0.9624	0.9619	0.9614	0.9609
140	0.9604	.....	.....	.....	.....	.....	.....	.....	.....	.....

Diesel-oil-volume correction factors save calculation time

To obtain volume at 60 F, take volume at actual temperature and multiply by factor in this table

► SINCE DIESEL FUEL-OIL sales and calculations are based on a standard volume at 60 F, it is necessary to correct the actual volume, at any given temperature, to the corresponding standard volume. This table helps you perform this operation in one easy step.

The factors listed were derived from the formula:

$$V_{60} = V_a [1 - C(60\,F - T_a)]$$

where V_{60} = std volume at 60 F, gal
V_a = actual volume, gal
T_a = actual temperature, F
C = coefficient of expansion .000495 per F

Because of the variation in coefficients of expansion for different grades of diesel fuel oils, standard volumes figured from this table will not be exact. Results, however, will be close enough for most purposes. Here are a couple of typical applications:

Problem 1: Your totalizing meter shows that a tank car has delivered 9500 gallons of diesel oil. Measured temperature shows that oil is at 50 F. Find the equivalent standard volume that you should be charged for.

Solution: Enter the table at 50 F. Correction factor is 1.0049.

1.0049 × 9500 gal = 9546.6 std gal

Problem 2: Same as problem 1, except that measured temperature is 95 F. Find the equivalent standard volume.

Solution: Enter table at 95 F. Correction factor is 0.9826.

0.9826 × 9500 gal = 9334.7 std gal

For information on an exact method of solution for diesel oils with other coefficients of expansion consult the ASTM—IP Petroleum Measurement Tables, No. 5, 6 and 7.

BY HOWARD HOLCOMBE,
Los Alamos, New Mexico

© POWER

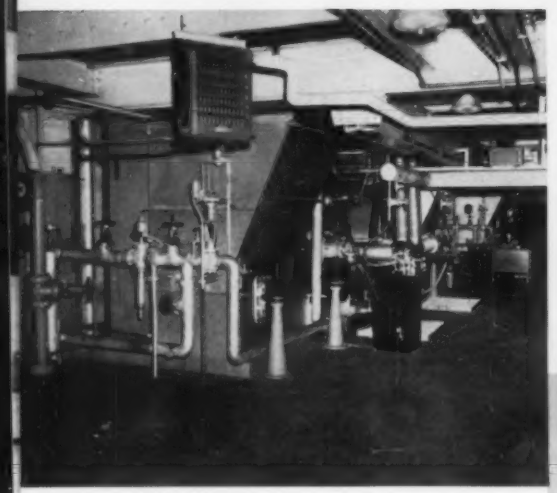
STEAM *helps make* STEEL

The United States Steel Corporation has purchased twenty-one steam generating units from Riley in the past fourteen years. Among these are the three steam generating units installed at Fairless Works.

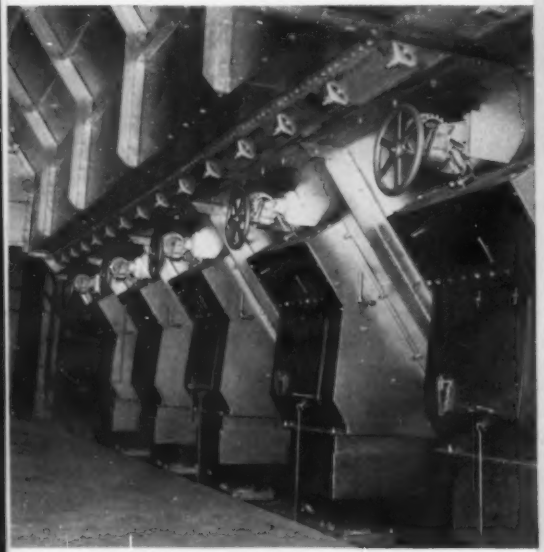
These three 300,000 lbs./hr. units were designed for blast furnace gas fuel primarily, but can also develop full capacity on coke oven gas or liquid fuel.

The desired steam temperature control range when firing blast furnace gas is obtained by the medium of a submerged heat exchanger in the lower boiler drum. Each unit is designed for future conversion to pulverized coal with Riley's exclusive single header hopper bottom furnace.

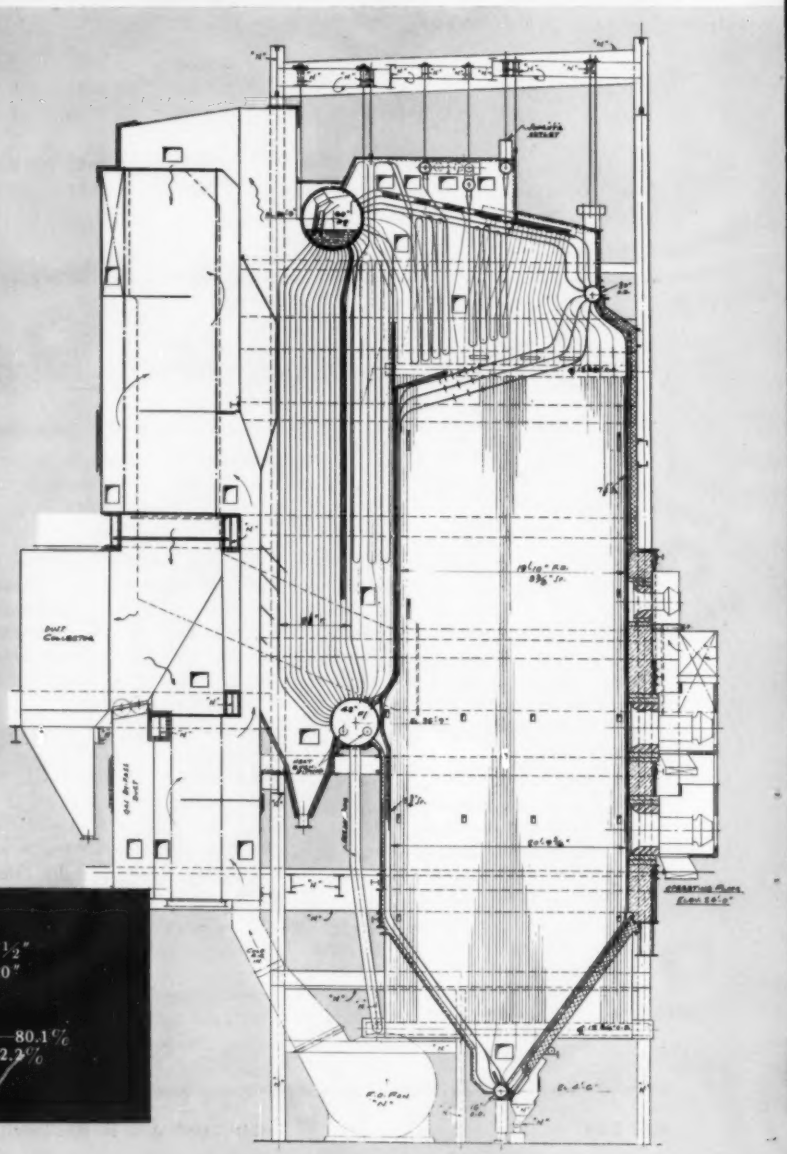
Other Riley units are operating at U. S. Steel plants in Braddock, Clairton, and Rankin, Pa., at South Chicago, Ill., and Gary, Ind. Three units are presently being installed at Johnstown, Pa.



Firing Aisle—showing controls for two of the three 300,000 lbs./hr. boilers at Fairless Works.



Riley Single Header Hopper Bottom construction reduces over-all height of unit and eliminates cost of separate hoppers.

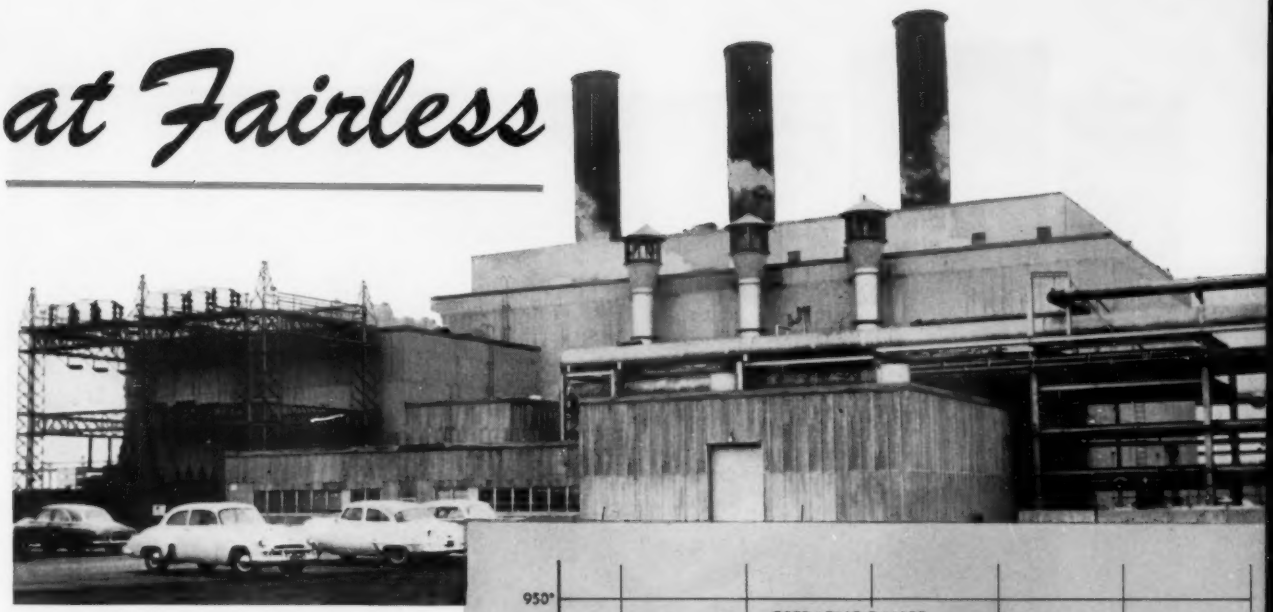


ENGINEERING DATA

Capacity—300,000 lbs./hr.
Design Pressure—885 psig.
Steam Temperature—900°F.
Heat Release per cu. ft. of furnace volume—18,300
Furnace Volume—26,570 cu. ft.
Furnace Width—25'7½"
Furnace Depth—19'10"
Furnace Height—57'
Efficiency
Blast Furnace Gas—80.1%
Coke Oven Gas—82.2%
Oil—86.4%

GIBBS & HILL—*Consulting Engineers*

at Fairless

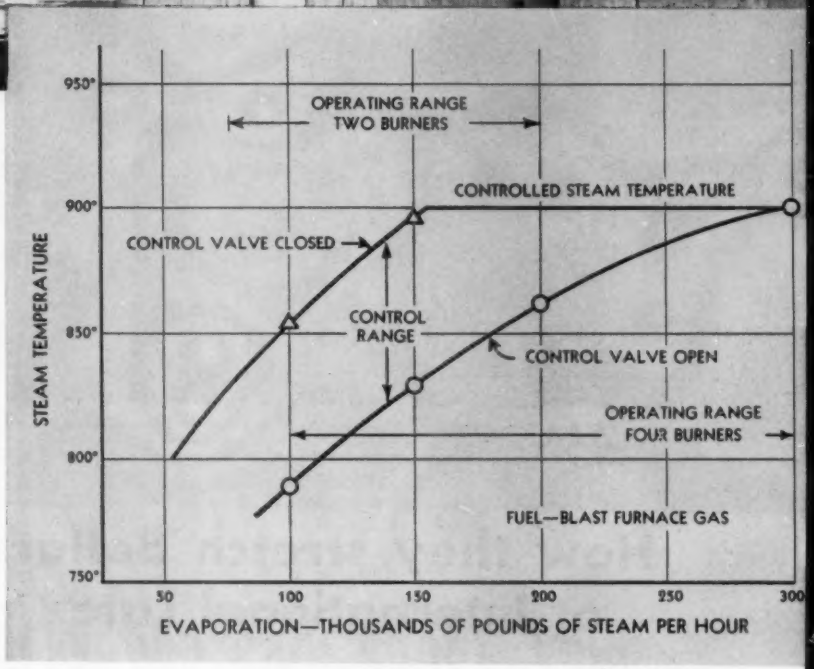


Boilers feature Constant Steam Temperatures Down to Half Load . . .

2 to 1 Control Range

Graph shows the wide range of temperature control obtained on each of the three Riley units when firing with blast furnace gas burners.

GIBBS & HILL—*Consulting Engineers*



A few other users of Riley units featuring Riley Single Header Hopper Bottom Furnaces

Whippany Paper Board Co.
Carbide & Carbon Chemicals Corp.
Colorado Fuel & Iron Corp.
Celanese Corp. of America
Monsanto Chemical Co.
Continental Can Co.
Hooker Electrochemical Co.
U. S. Rubber Co.
Western Electric Co.
Esso Standard Oil Co.
Swift & Company
Bird & Son, Inc.
Allis Chalmers Mfg. Co.
North American Aviation, Inc.
Calumet & Hecla Consolidated
American Viscose Corp.
Syracuse University
Great Lakes Steel Corp.

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RILEY
STOKER CORPORATION

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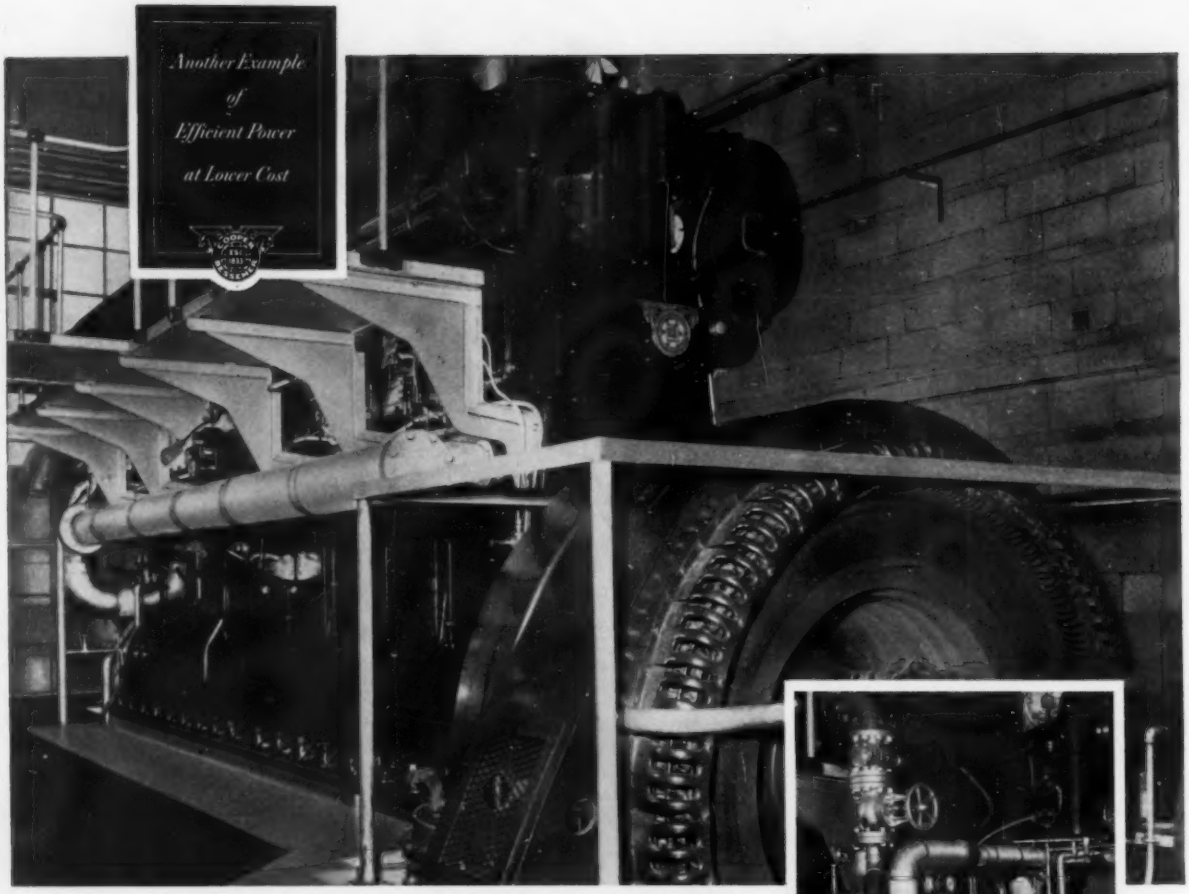
COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • ECONOMIZERS
WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS



Latest of three Cooper-Bessemer LS-8 diesels in International Latex plant, this supercharged 1700 hp unit provides 40% thermal efficiency. End view at right shows piping setup for jacket water heat recovery contributing to 80% over-all thermal efficiency.

How they stretch dollars at International Latex

● Here's a diesel plant that is turning in amazing results—*80% over-all thermal efficiency!* The engine is a Cooper-Bessemer supercharged LS-8, installed in the International Latex plant at Playtex Park, Dover, Delaware.

To start with, this modern LS diesel exceeds 40% thermal efficiency — performance rarely equalled! On top of that, an ingenious jacket water heat recovery system captures for processing use another 40% of the total heat input.

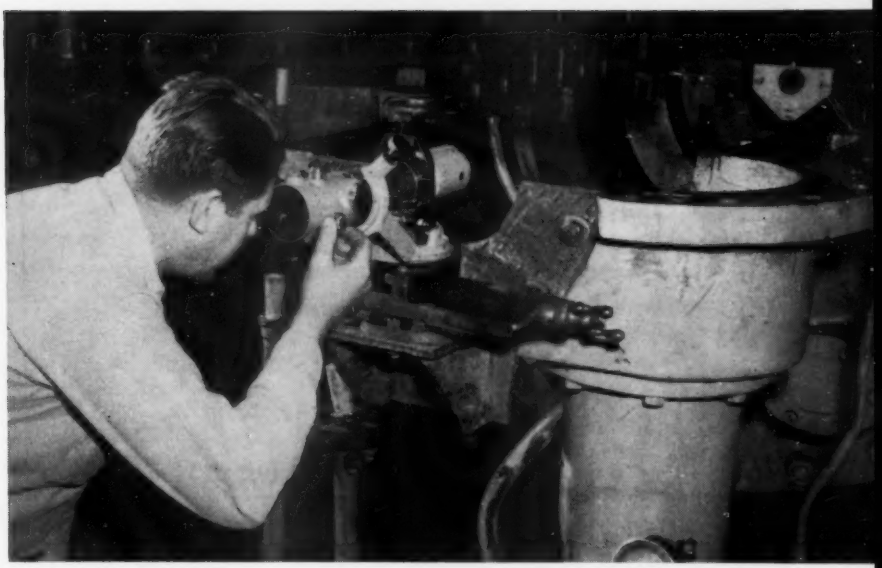
In all there are three Cooper-Bessemer LS-8's in this International Latex plant—the supercharged unit shown above and two previously installed atmospheric LS-8's. Later on these original LS-8's can be easily converted to supercharged operation to boost their output and to match the remarkable efficiency of the new unit.

Whatever your power needs may be, check with Cooper-Bessemer. Find out how much you stand to save by the best to be had in efficiency and long, trouble-free engine life.

The
Cooper-Bessemer
Corporation

MOUNT VERNON, OHIO — GROVE CITY, PENNA.

New York Washington, D. C. Bradford, Pa. San Francisco Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela Cooper-Bessemer of Canada, Ltd., Halifax, Nova Scotia Gloucester, Mass. New Orleans, La.



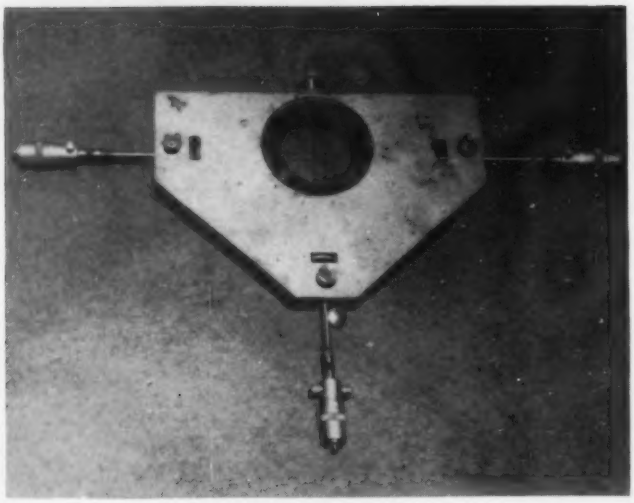
NOW you can 'shoot' your bearings in line

At long last, here's a telescope that aligns your bearings within a thousandth of an inch or two, and does away with the ancient time-consuming tight-wire job we all dreaded

By W B WARNER and R H BRENNER
Consolidated Edison Co of New York

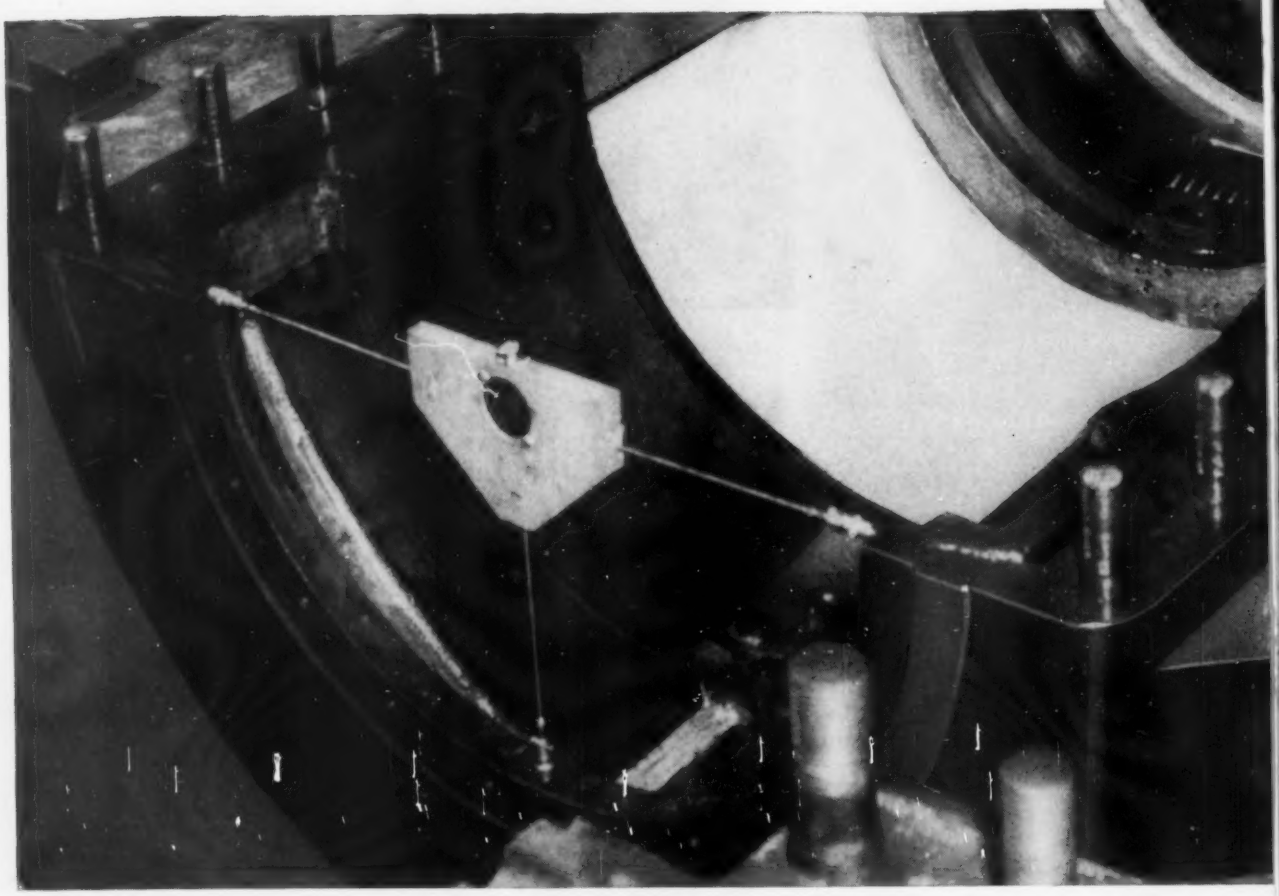
Turn page for details ►

These targets with mikes are heart of scheme...



MICROMETER target holder is a steel plate shaped to hold three inside micrometers. With target usually placed in first and last bearing bore of machinery to be aligned, micrometers are adjusted to position the cross-wires in exact center of bearing bores. Telescope is set on zero, instrument adjusted horizontally and vertically so target cross-wires and telescope reticle cross-hairs are in same line of sight.

This line of sight then becomes a reference line for the entire length of machine. Targets are centered with micrometers in all other bores of turbine and generator stator. Then measure center-line displacement of these other bores from reference line on micrometer and record. From these readings, plot curve on cross-section paper showing "as found" alignment of the bearings.



INSIDE MICROMETERS center the targets, the telescope then establishes a reference line . . .

...here's your know-how

... you're ready to align other bearings

► NOT WIRE, but an alignment telescope is used to align turbine-generators at Consolidated Edison Company of New York. This is more accurate, easier to use, and faster than the old tight-wire method, which has been standard for years.

Alignment telescope has been used in the aircraft industry to position in space fuselage and airfoil wing sections without needing large steel jigs.

Problems. There are two basic problems in aligning a turbine-generator: (1) positioning the three to six bearing supports so turbine spindle or spindles are in line with generator rotor shaft at coupling or couplings. (2) allowing the stationary parts (generator stator, turbine cylinders and all fixed internals of turbine—diaphragms, blade rings, dummy rings, etc) proper clearance for moving parts of machine.

Tight-wire method is to stretch a small-diameter wire through turbine-generator with wire ends positioned on proposed center line of machine. Once tight wire is in place, the various parts are aligned to wire with inside micrometers. You measure from wire to round openings or bores in parts to be positioned. By comparing micrometer measurements and doing a lot of arithmetic, relative position of parts to wire are found and parts repositioned accordingly.

This may sound simple if you haven't tried to align with wire, but it's a time-consuming process. Wire is subject to vibration, and is a hazard and obstruction to work going on. Besides, the many micrometer measurements and involved arithmetic often lead to human errors.

Telescope Method. We selected a 60-power Farrand Alignment Telescope, capable of focusing from 18 inches to infinity. In the eye piece is a reticle, horizontal and vertical micrometer scales, and a precision level. Both the large range of displacement and level are desirable for turbine-generator alignment.

Telescope's optical center line replaces tight wire as center line is projected throughout machine's length. Optical center line is set level with the built-in precision level. This optical center line can be displaced vertically and horizontally, plus or minus 0.120 in. Telescope is sighted on cross-wire targets mounted in a target holder, fitted with standard inside micrometers at sides and bottom. Targets fit into bore diameters of 12 to 40 inches. Telescope may be mounted on an end-bearing pedestal or on a separate stand, apart from turbine, *photo.*

Results. Alignment-telescope method is more accurate, less costly, takes less time. Besides, it permits other work to go on in area, even installing or removing of internal turbine parts.

We developed telescope method for heavy machinery on two different turbine-generators. A third unit (53,000-kw topping job) was then completely realigned this new way. Existing alignment was found by centering optical center line through No. 2 and No. 4 bearings. For final realignment, we established a level optical center line through No. 6 bearing. We aligned other bearings, generator stator, and rotating and fixed turbine parts to this center line. As a result, we had to realign and regrout three bearing pedestals and turbine sole plates.

On installing the turbine spindle and generator rotor, all coupling checks showed satisfactory alignment.

Turn page for more details ►

REFERENCE LINE is established with two targets at extreme ends of machine and telescope on stand. By placing the targets in other bearing bores to be aligned, as here, exact amount of misalignment in thousandths of an inch is quickly known

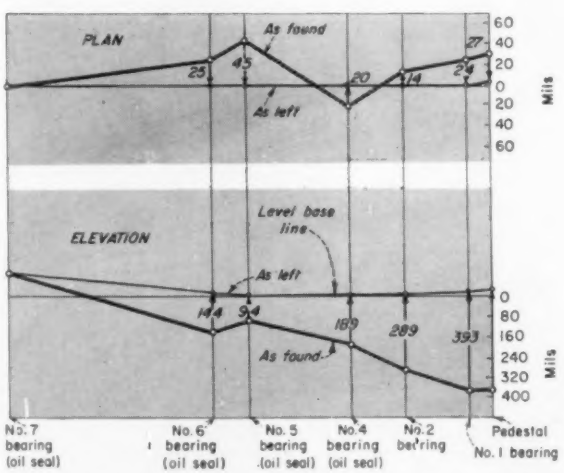
Plot curves of both plan and elevation alignment, *sketch*, as you line up the machine. To do this, set up telescope, as explained before. Center a target with inside micrometers in bearing bore at each end of machine for finding the reference line. With this line established by the telescope, you are now ready to center targets in all other bores to be aligned—or in bores you want information on, whether or not it is practical to align at this time.

From these readings, plot plan and elevation curves on cross-section paper showing the "as found" alignment. Indicate misalignment in thousandths (mils), using enough units to each square to have exaggerated lines far enough apart for easy reading. Also, mark off approximate positions of bearings being aligned with vertical lines.

After making needed shim changes under parts, such as generator stator and bearing pedestal sole-plates, use the telescope again to check and verify the adjustments. After all adjustments are complete, plot the "as left" curve for future reference. Result will be an easy-to-read chart similar to the one shown here.

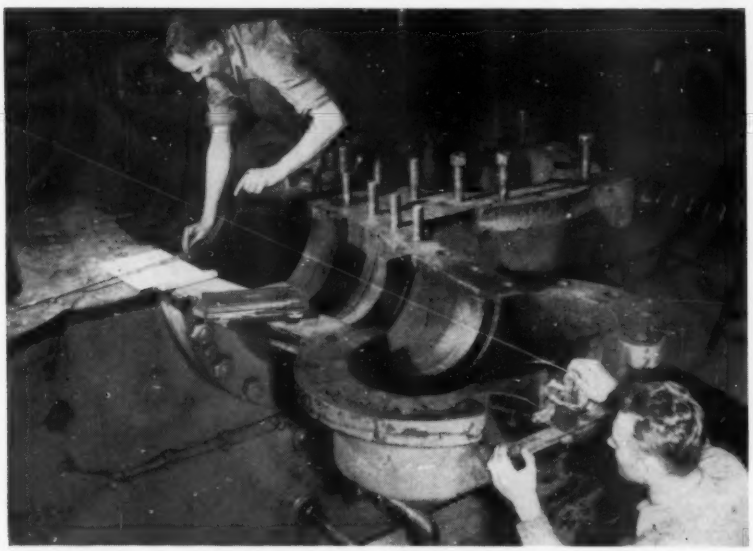
While no time studies have been made either with tight wire or telescope, personnel using both feel that this method has saved much time and certainly has done a better job.

Use of telescope is naturally not confined to turbine-generator sets. No doubt you will find many uses as time goes on.



CURVES show reference line, "as found" and "as left" lines. Mark off approximate positions of the bearing bores being aligned. Cross-section paper is handy for this use, roughed out on job as each bearing is being aligned. Manufacturer's data furnish much of the information needed for this important work

If you can't make use of this new method, you may want to align with tight wire



MEASURING distance from bore to wire calls for very fine sense of feel. If there are vibrations or kinks in wire, chances are that readings will not be very accurate

WEIGHTS hung on wire, at both ends of machine, and wire length affect wire sag

GOOD MECHANIC is needed to work with tight wire. Work is slow, holds up job

Tight-wire has been used for years to align bearings of heavy machinery. Wire acts as a datum (something actual or assumed) from which measurements are taken with inside micrometers. In this way parts, such as bearing pedestals, turbine cylinders, blade rings, dummy rings, diaphragms, etc, are aligned.

Wire is stretched tight through center of bearing spaces in machine, with each end of wire fixed in space, according to bench marks established by the surveyor. Micrometer measurements are taken from various bores against wire throughout length of machine.

By adding, subtracting and dividing the micrometer readings and allowing for tight-wire sag, you can find where the center of bore is in relation to where it should be. Then various parts found out of line are moved or adjusted into correct position.

Disadvantages. You can see that this tight-wire method has several disadvantages. One is that it's time-consuming. The job is tedious and must be done by a careful mechanic with the right feel for the job. Then, again, the wire sag varies on each job, depending on its length, diameter and tension. (Tension is obtained with either a spring or a weight at one end.) If any of these factors is not correct, wire sag is naturally inaccurate. Kinks in the wire also lead to inaccuracy.

Also, if the tight wire is displaced from center of bore, angularity of micrometer to wire to a true radius leads to inaccuracy. Errors are also made when manipulating the micrometer readings, together with sag of wire to find true position of a particular part of turbine with respect to datum line.

At times, the wire is bumped, and then it must be reset again. Or the wire vibrates, giving false micrometer measurements. Another disadvantage is that it's impossible to remove a cylinder, blade ring, diaphragm, bearing pedestal, etc, to make repairs or adjustments for alignment purposes while there is a tight wire through the machine's bore. These are some of the reasons that make optical tools a welcome newcomer to the modern maintenance man.

OPERATORS' NOTEBOOK 74

Look inside your jet-flow

How valve works

► THREE TYPES of high-pressure steam-drum safety valves in general use are: (1) jet flow (2) huddling chamber (3) nozzle reaction.

Jet flow makes use of both reaction and velocity of escaping steam. Static pressure on disk overcomes spring tension, causing steam flow. Escaping steam strikes against piston and is deflected downward against nozzle-ring, discharging into body. This reactive force lifts disk higher, thereby increasing area of flow, therefore velocity.

As velocity increases, partial steam discharge takes place through the controlled orifices in guide assembly. Because of its confined velocity, the steam creates an upward force, lifting the valve still higher. Position of disk at "pop" lift is such that area of discharge is greater than area of nozzle; excess accumulation of pressure needed for full lift in huddling chamber and nozzle-reaction types is unnecessary for full capacity in jet-flow valve.

As pressure in boiler falls, velocity through orifices is reduced and valve's disk drops to intermediate lift momentarily. After that, diminishing reactive force controls further reseating, the same as in a reactive valve.

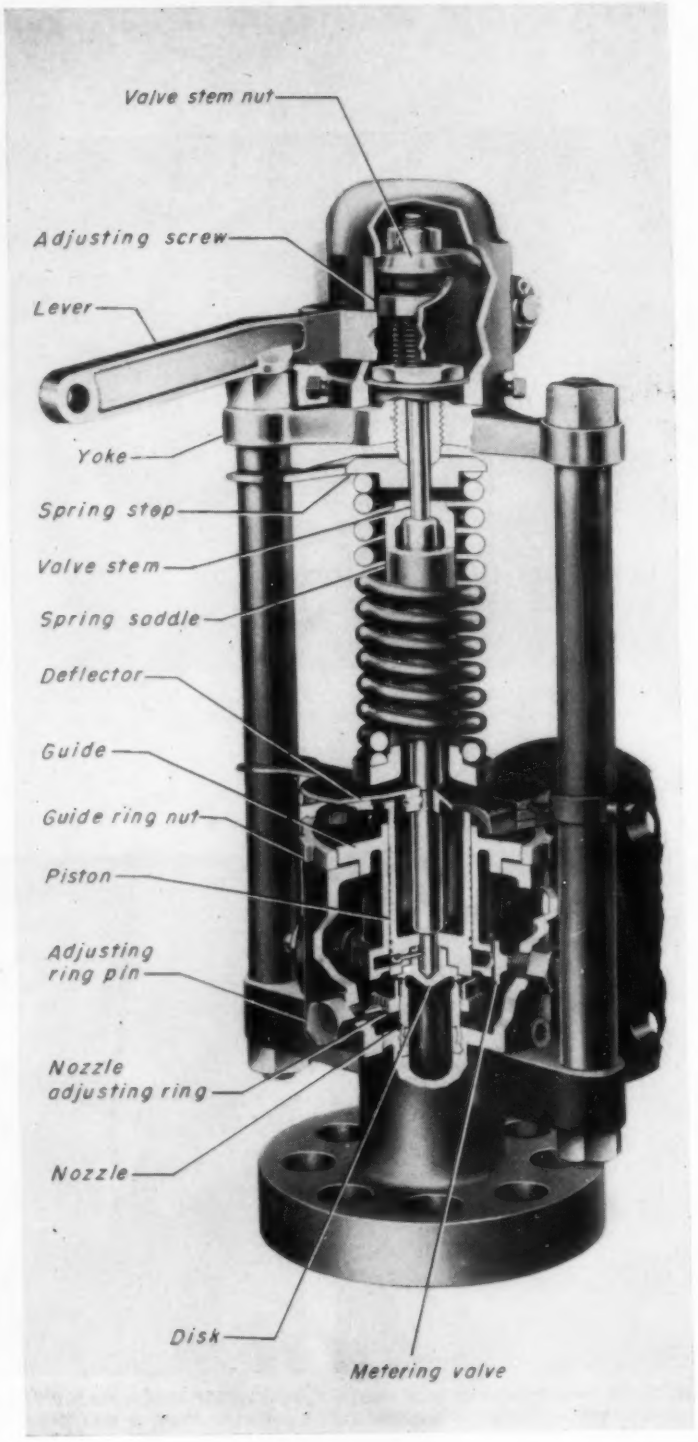
Blowdown adjustment is by an entirely different method from that in other type valves. In this jet-flow-type relief valve, the blowdown is controlled by the location of the exhaust belt reaction-lip, which is varied by adjusting the guide vertically.

Adjusting. If valve opens cleanly but does not seat sharply, nozzle ring is up too high. Lower by removing adjusting ring pin and turning nozzle adjusting ring to left one notch at a time between trials until valve seats sharply with a metallic thud. Adjust ring with screwdriver.

If blowdown is too long, nozzle adjusting ring is too high and must be lowered. If valve warns before popping, nozzle adjusting ring is down too low and must be raised. Turn ring to right one notch at a time until the warning stops completely.

Caution: When raising nozzle-adjusting ring, keep boiler pressure well below popping pressure or gag the valve while making adjustments. To protect personnel, always gag safety valves when adjusting. This is important.

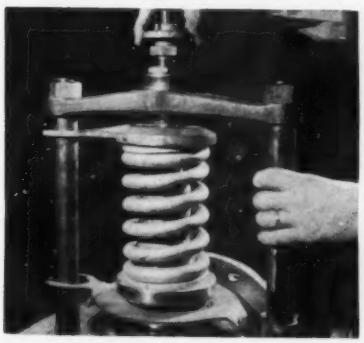
Photo, courtesy Foster Engineering Co



safety valve, keep it working

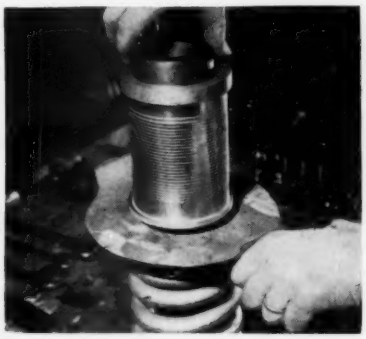
By STEVE ELONKA
Associate Editor

How to overhaul

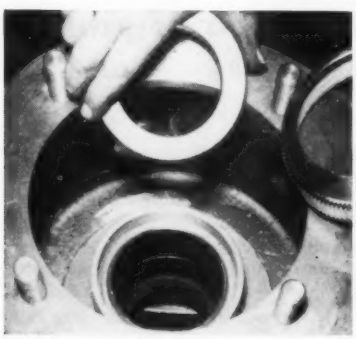


1 Remove lifting lever and screw down valve-stem nut. Spring assembly can be removed without changing the setting

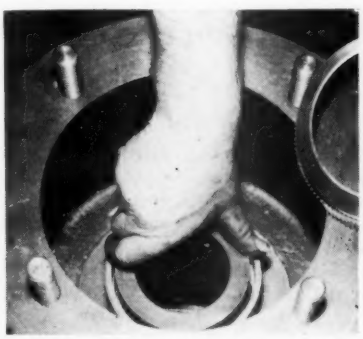
2 Now lift out the valve assembly in one piece and turn upside down on work bench so you can lap in the valve disk



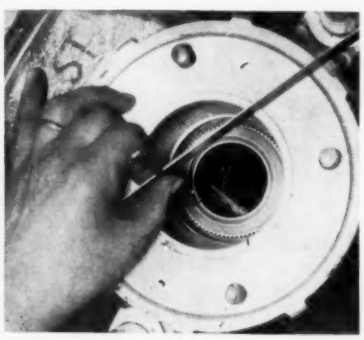
3 Lap disk with lapping ring and paste to remove slight depressions. Give it oil rub; clean by dipping in solution



4 Unscrew adjusting ring from nozzle, examine nozzle seat that contacts valve disk. Only perfect seat is steam tight

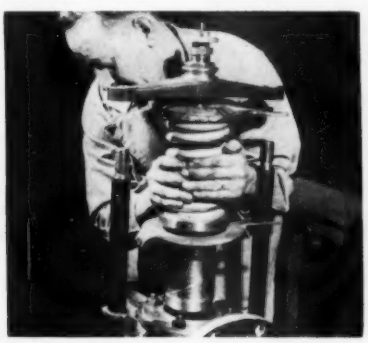


5 Lap in nozzle seat with lapping ring and paste. Again, give oil rub after lapping and rinse in cleaning solution

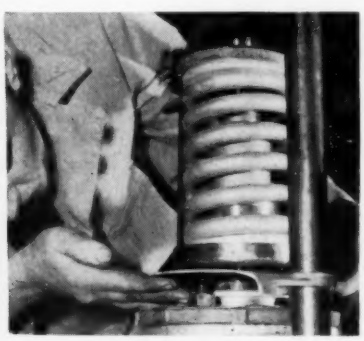


6 Replace adjusting ring and measure specified distance for that size from straightedge to lip of the adjusting ring

7 With adjusting ring locked in place and all the internal parts thoroughly cleaned, replace guide for disk piston



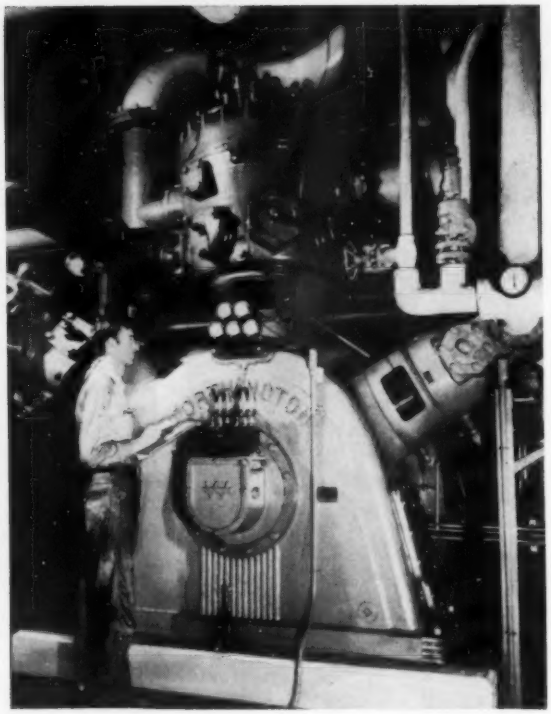
8 Valve spring assembly is now ready to go into place. Spring adjustment has not been disturbed and valve is set



9 With valve assembled, check the piston by moving with fingers. Piston must be free for valve to work properly

By N A FORAN *Watercooled Compressor Division*
Worthington Corporation

How safe is your soot-blower air compressor?



HERE'S THE ANSWER: *Careful operation of your...*

► THE KEY to a safe, smooth-running soot-blower air compressor is careful attention to details. Whether you are planning to install a unit or are maintaining and operating one now, here are points you should consider.

Installation. If your soot blower requires an air compressor of 25 hp or larger, chances are it's a 2- or 3-cylinder, water-jacketed type with intercoolers between cylinders and aftercooler following the last compression stage. This set-up is typical of most industrial and central-station arrangements.

First point on our check list is the air filter. Locate this piece of equipment in the cleanest, coolest spot available—outdoors if possible. Cool air boosts compressor capacity because of its greater weight per cubic foot. Filter should be sized on the basis of compressor displacement for minimum pressure drop. When properly installed, this unit keeps dirt and other foreign materials from fouling valves and scoring highly finished cylinders.

Cooling between compression stages not only reduces air temperature, but also condenses water vapor in the air. A separator and moisture trap that ejects this water automatically without losing the pressure seal on the system, is a must. Also, don't forget a safety valve and pressure gage on the intercooler shell, for protection against excess pressure and as a check on performance.

Aftercooler accessories include separator and automatic moisture trap, also a bypass line so the unit can be temporarily taken out of service for maintenance or cleaning, without interrupting air supply. Install your aftercooler as close to the compressor outlet as possible so high-temperature-air discharge runs are kept to a minimum. This prevents lube-oil carryover, which may collect on the pipes, from vaporizing in the hot air and forming a hazardous mixture. If a fire occurs because of poor lubrication practices (discussed later) or poor maintenance, the aftercooler is close by to cool the gas below burning temperature before it can spread to other parts of the system.

A safety valve in the aftercooler outlet, before the shutoff valve, protects the unit against excess pressure—even when the shutoff valve is closed.

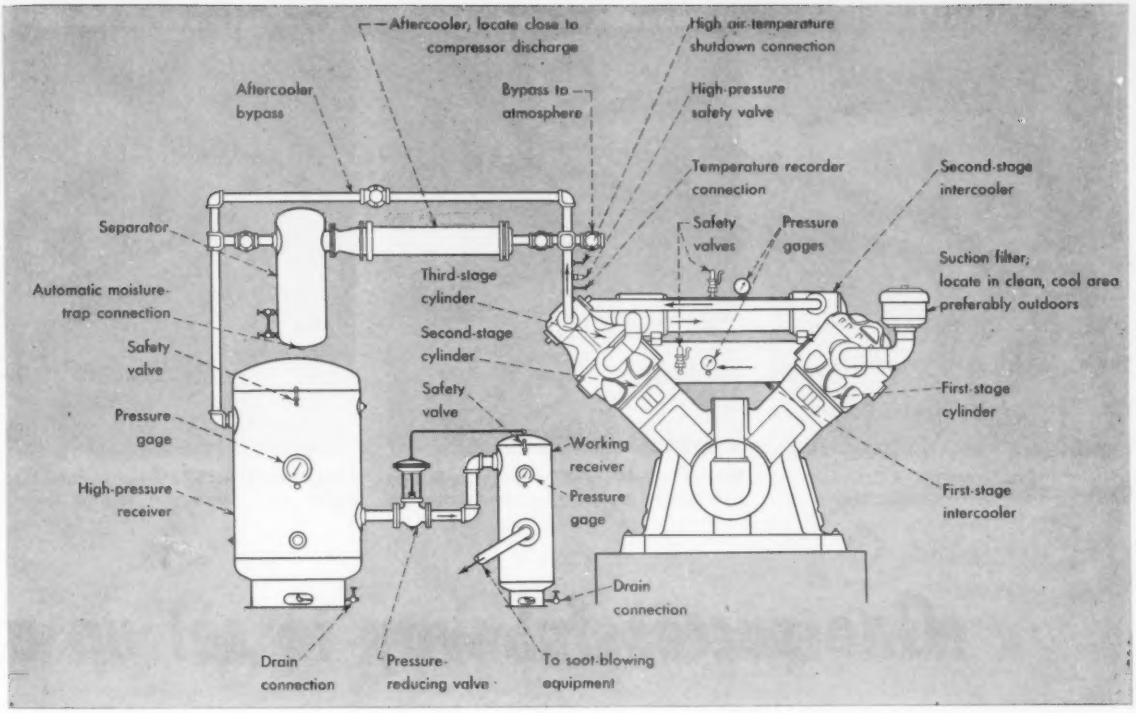
Receiver piping deserves special attention. Air must enter from the top of one side and leave from the bottom of the opposite side. With downward flow of air at reduced receiver velocities, entrained moisture or oil will drop into the receiver drain. Removal of condensate and oil should not be overlooked. Also, consult manufacturer's data for correct receiver safety valve and pressure gage.

Where 250-psi air is required for soot blowing, you can often cut initial costs by generating air at 500 psi and storing it in a high-pressure receiver. This unit is connected to a 250-psi receiver through a pressure-reducing valve. Substantial reduction in compressor size results from such an arrangement.

Thermal Protection. When it comes to temperature, air compressors are much like people—excessive temperatures mean trouble. Air leakage is the most common cause of high air-discharge temperature. It can occur through the valves, past the piston rings, between stages or through a gasket.

Lack of cooling water, at cylinder jackets or coolers, will show up as high air temperature almost immediately. To avoid this predicament, use automatic water valves that open when the motor starts. Remember, it takes only one forgetful operator to put the entire air supply out of service.

Have an excess-temperature shutdown device in the discharge line of each cylinder to protect expensive equipment



...planned installation insures safety and reliability

as well as operators. This is nothing more than a heat-sensitive bulb that closes a contact when the temperature exceeds safe limits, thereby interrupting current to the motor. A temperature recorder in the air-discharge line is useful in establishing trends that often stop troubles before they start.

Lube System. Poor lubrication is the result of (1) too much oil (2) lack of oil (3) poor grade. Any one of these conditions will eventually cause a costly shutdown of your soot-blower air compressor. Here's a simple procedure that steers you clear of these troubles. When starting a new compressor, feed a liberal amount of oil into the cylinders, until the bore becomes glazed. This happens after a week or two of operation. Check for glaze by removing a valve and inspecting the surface of the cylinder bore with a flashlight. If you're satisfied that the cylinders are properly broken in, gradually cut back on the oil supply until no more oil than is absolutely necessary is admitted to the cylinder. Don't forget, excess oil either mixes with the air or deposits on your pipes, putting an extra load on the separators and creating an additional maintenance problem.

If the compressor is force-feed lubricated, you can't afford to be without an oil-failure pressure switch, which interrupts motor current when oil pressure is too low. Passing the oil through a filter keeps dirt out of the bearings and running gear. Such filters are often standard equipment on compressors having force-feed lube systems.

Periodic Maintenance. You avoid many a tough operating problem by sticking to a regular maintenance schedule. Inspection of all elements from the filter to the receivers pays operating dividends. Keep log books, and record the condition of each item.

Careful cleaning of the filter not only eliminates excessive pressure drop, but also adds to the life of the compressor by minimizing wear on the pistons, piston rings, valves and cylinders.

Intercoolers and aftercoolers also have their place on the maintenance schedule. Clean the tubes at regular intervals to maintain efficient heat transfer. Inspect the water side of the cooler to make sure no foreign materials are obstructing the smooth flow of cooling water. Open receiver drain valves about once every four hours to eliminate the accumulation of water and oil.

When repairs are made, enter them completely and accurately in your log. And don't forget to record the date. You'll find that regular review of well-kept records is an excellent yardstick for future operating decisions.

Other Safety Features. Operators hold differing opinions on whether to place a high-temperature shutdown device in the cooling-water discharge line. The best argument against the practice is that this purpose is served more efficiently by the same setup in the air-discharge line. If, for some reason, the cooling water is not turned on, the temperature bulb in the water-discharge line will not be surrounded by water but by lukewarm air—a rather large loophole for so important an item. If you're still disposed to use such a setup, make sure it's operating in conjunction with similar arrangement in the air-discharge line. Then, you'll have foolproof protection.

Some compressor controls have an over-pressure shutdown switch in the air-discharge line. If pressure exceeds safe limits, motor current is cut out. While it can be argued that this is a duplication of effort since temperature rises with pressure, it does provide an extra measure of safety if either the pressure or temperature cutouts fail.

The John Hancock Co, using 15 men, replaces 43,000 fluorescent lamps in about 45 days. Experience has proved their approach is . . .

REMOVING LOUVERS and lamps is first step in the group-replacement sequence

CLEANING FIXTURES follows; crew then installs new lamps and washed louvers

One successful way to set up a

► THE SYSTEM for lighting maintenance set up for the John Hancock Mutual Life Insurance Co building in Boston works out so well that the company plans to continue using it indefinitely as a standard procedure.

They have just completed their third group-relamping operation. Previous group-replacements were made in 1950 and 1952.

Here's the inside story on how they replace 43,000 fluorescent lamps and clean 21,000 fixtures in 45 days, without disrupting normal work.

Method of Operation. An outside contractor, working at night, does all the changing of lamps and cleaning of fixtures. He uses 15 men, including one foreman, for the job. Twelve of the men work in four 3-man crews to remove louvers and lamps, wash fixtures, then put in fresh lamps and clean louvers. Two other men form a crew for washing and drying louvers. Foreman takes care of supervision, pitches in where a crew needs help.

Each 3-man crew consists of two men who stand on a rolling stage and take care of the cleaning and relamping operations, plus one man who remains on the floor. He swaps old lamps for new, replaces dirty louvers with clean ones for the men on the stage.

The four crews work on the same floor to expedite the job. Building layout is such that it is advantageous for three groups to start in the main central portion of the floor, while the fourth goes through private offices, toilet rooms and hallways. When finished with these "special" areas, the fourth crew works with the other three until the floor is completed.

The men who stay at floor level not only feed lamps and louvers up to the stages, but also supply clean water for washing fixtures, dispose of lamp jackets and cartons, move and replace furniture where necessary. They also move racks of louvers to and from the washing station in the basement and get enough lamps from storage to keep up with the demand. The foreman helps out on these operations, also keeps an eye on over-all progress.

These men do not attempt to correct electrical troubles. If a lamp will not burn, they put in a new starter. If this does not correct the trouble, they hang a tag on the fixture, leaving repairs to electricians.

In the basement, two men take care of washing and drying louvers. Movement is from rack to washing tub, to rinsing tubs, back to rack and into drying compartment. Two fans mounted on top of the drying cabinet provide forced-air circulation. This cuts drying time from 25 minutes in still air to seven minutes in the cabinet.

One elevator is reserved for the exclusive use of the lighting maintenance crew, to keep up with the flow of materials from lamp storage rooms and louver-washing station. This prevents any bottleneck of service for the other employes who may be working at night.

Foreman makes sure that crew reassembles all stripped fixtures before they quit for the night.

Contractor does not sort the used lamps to determine if any will be saved. The regular building-maintenance crew takes care of this job the next day.

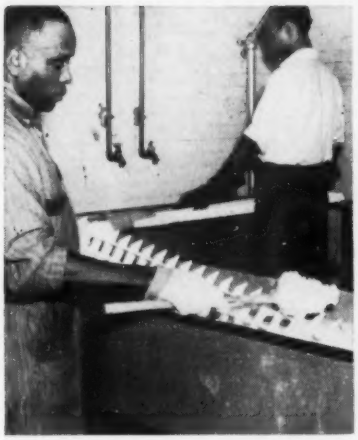
Special equipment used for relamping was made in the John Hancock shops. This includes the trucks for carrying lamps, the louver racks, wash tubs and drying cabinet. Photos, *above*, give a good idea of the simple construction of each unit.

Platform height of the rolling stages is carefully planned to clear most obstacles, yet provide a comfortable working height. Horizontal pipes provide convenient handholds and also strengthen the construction.

Lamp trucks are simply made, with the top and one end open to allow easy loading. These trucks hold the used lamps. Cartons of new lamps may be stacked crosswise on the top, thus keeping all lamps within easy reach.

Louver racks are mounted on a flat truck with casters for easy maneuvering. Upright frame in center of truck is studded with wooden pins to support a total of 30 egg-crate louvers. As all fixtures in the building are 30- and 40-w, the same racks are used throughout.

Wash tubs were also specially built to handle this job. The three tubs are each 14x14x60 in., arranged in a U shape. This allows easy movement from



LOUVER WASHING needs special setup; three tubs allow one wash, two rinses

DRYING TIME is greatly reduced by this cabinet with fans for circulating air

INSTALLATION DATE marked on the lamp tells when replacements were installed

group lamp-replacement program

wash to rinse operations, and cuts down on maneuvering louver racks in the basement area.

The drying cabinet has two fans mounted on top to provide forced-circulation air. Cabinet is a boxlike structure made of beaver board, corresponding in size to the louver racks.

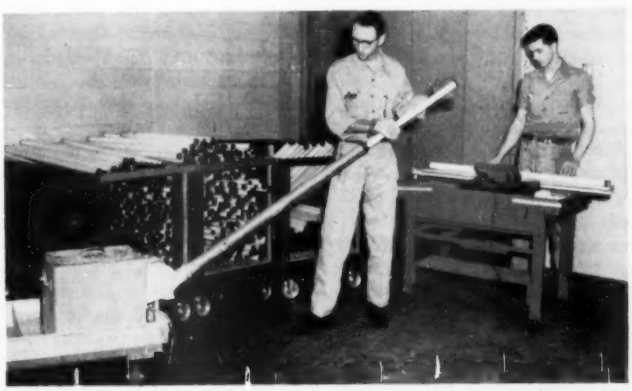
After three relamping programs, Hancock feels that ordinary fluorescent lamps have given their best service during the first 5500 hours of operation. This is about 75% of the rated life of 7500 hours. After 5500 hours, total burnouts are only 5 to 7%, but light output of all lamps has been reduced. This lower output, coupled with dirt on fixtures, reduces room brightness considerably. Readings taken just before and just after group relamping showed a change from 31 to 58 foot-candles.

The maintenance department no longer tests used lamps to decide whether to keep them. They now discard all lamps that have burned six months or more. This means that all lamps from the previous group replacement are automatically thrown out. Any lamps put in service to replace individual burnouts between group replacements are dated with crayon. When removed, they are kept only if the date shows less than six months' service. These lamps are then available for future single burn-out replacements.

Management feels that contracting this job to a professional cleaning company saves both time and money. They had once planned to hire a team of six men to take care of this work exclusively. But after figuring salaries, insurance, taxes and overhead, they found cost per fixture was too high. They calculated that the men would complete the building in six months, but would still have to be kept on the payroll.

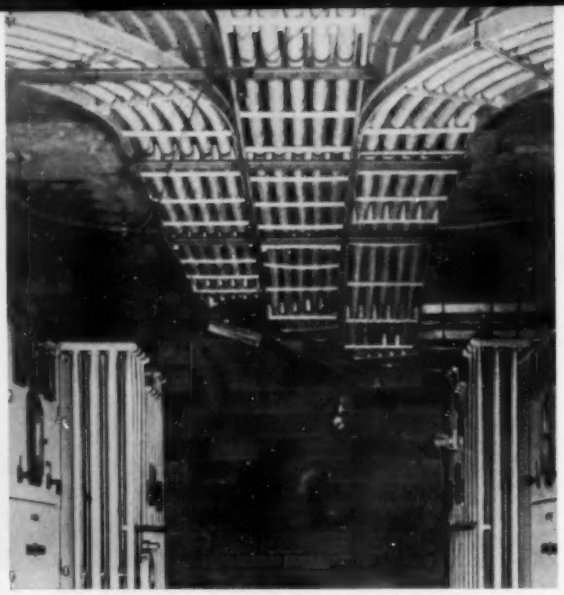
Letting the job out on contract avoids the necessity of making permanent additions to the maintenance force, thus saving a substantial amount. The few tubes that burn out between group replacements are now replaced by a 2-man crew, working only part time on the relamping operation.

Compared with replacing lamps on a single-burnout basis, Hancock feels that the advantages of group relamping are the freeing of electricians' time, better over-all lighting and improved appearance of the building.



OBSOLETE SYSTEM. In previous relampings, maintenance men checked used bulbs for brightness. The present system of dating individual replacements makes this unnecessary. Also, grinding machine is not used now as old lamps are handled through regular disposal channels

1 **PRIMARY SUBSTATION** is your first stop. Check transformer temperature, oil level. Operate breakers when plant is down



2 **PRIMARY FEEDERS** get checked too. Little chance of mechanical damage if in conduit or armor. But watch open runs

Adopt this 4-point monthly check of

'Monthly inspection of primary, secondary subs, loads and feeders is the core of a sound electrical-maintenance plan,' says Jim Sparks of Seattle, Wash. Here's the way Jim does it

► EACH YEAR I get to see many industrial plants throughout the country. And since I concentrate on the electrical side of plant operation, I know firsthand the feeling of many plant operating men on this matter of electrical maintenance. Briefly, a growing number of engineers are taking one big chunk of their electrical maintenance responsibilities for granted—their electrical distribution systems.

True, modern distribution equipment requires less maintenance than older gear. This is a tribute to equipment manufacturers, who for years have been working toward building top reliability into their products. But you must still set up some system of regular checking for trouble signs. Otherwise, you may some day face up to a major breakdown.

The Approach. Many young engineers start out on the wrong foot in setting up any electrical maintenance plan. All too often they organize an elaborate inspection program, then find they can't follow through; their men just haven't the time. Soundest approach I've found is to work up a simple monthly check-plan aimed to cover lightly the complete distribution system, supplemented by a more complete yearly repair and maintenance program. If at all possible, carry out this second phase, the annual maintenance, during the yearly vacation shutdown.

I regard the monthly distribution check in much the same light as a periodic look-see by the family doctor. The plant man must decide just how far to go in the monthly check-visit, yet assure himself a sound plan is under way.

I've been faced with the problem of what to include in the monthly check, and here are the highlights as I see them. Use these pointers merely as guides since your plant may require either changing emphasis or including other equipment in the plan. Most of these tips can be applied directly to plants buying their power from a utility, and with a little revamping, to plants generating their own electric power.

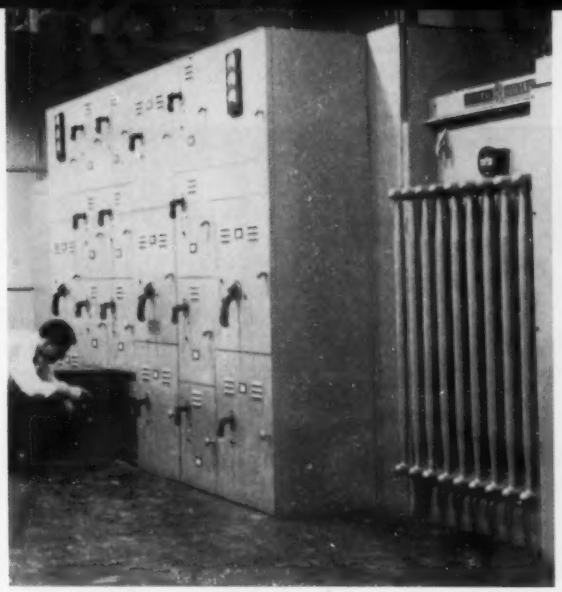
Primary Substation. Start your monthly check at the incoming primary substation. Here you will usually find three major pieces of equipment: circuit breakers, transformers, feeder cables.

Breaker inspection splits into a general look-over and a test operation. Check for signs of oil leakage both from the tank itself and around potheads. Make note of any leaks and, if slight, leave them for annual maintenance. Make a visual check for signs of overheating where you have load-interrupter switches and fuses. This is easy to do without shutting down.

Make breaker tests during no-load periods. This check tells you quickly whether breaker is in tripping condition. At this time, don't bother about the relays, but do include them in the annual maintenance.

Give the transformer a going-over for oil leaks. Check maximum-rise temperature indicator to spot if unit has overheated since last visit. Many plants make a daily check on transformer temperatures and enter readings in the plant log. Check for rust on transformer case and, while there, check the oil-level indicator. If you find any indications of trouble, test winding insulation with a megohmmeter with transformer off the line. If all seems clear, leave the megohmmeter check till the annual maintenance period.

There is little you can tell about cables and buswork by just looking, unless there are readily apparent signs of trouble. If you have a grounded neutral system, cable failures will show up quickly since the overload relays trip. Where the plant has an ungrounded



3 **SECONDARY SUBSTATIONS** need transformer and breaker check. Inspect the breaker contacts for overheating, pitting

4 **LOAD CHECK** is next, but not as shown. The split-core instrument is OK but never lean over a live bus, even at 480 v

your electrical distribution system

primary feeder setup, make frequent megohmmeter checks for insulation resistance. In either case, check all the cable and bus supports, potheads and insulators.

Don't make the mistake of setting up a routine check list and following it blindly. Keep on the alert for any signs of impending trouble. That even holds for inspection of the substation's general structure, locks, ground cables, meters, instrument transformers where accessible, bus work, disconnects, etc.

Primary Cables. I've found a walking inspection of overhead primary distribution feeders pays big dividends. You can often spot a sagging cable, busted insulator or damaged insulation. Look, too, for leaking process piping that might damage the distribution lines.

If cables are underground, pull off several manhole covers. This is especially important in chemical plants where process-chemical seepage may be saturating the soil and eventually working its way into cable insulation. Sniff for gas in underground manholes.

Keep close check on construction work going on in the plant to make sure there's no interference with the distribution system. I've seen outside contractors come into plants to install machines or make major alterations, then accidentally drill or cut through live high-voltage primary cables. It might pay you to paint a marker on all exposed feeder runs and lay some added protection around all high-voltage underground cables when they're going in.

Secondary Substations. The important part that secondary unit subs play has come in with industry's wide adoption of the load-center method of power distribution. In the days of long, low-voltage feeders running through the plant from an outdoor primary sub, there just weren't any secondary subs to worry about. Now the modern plant is generally fitted with transformers and switchgear right close to the load areas.

Where you have a load-center setup, make a check on each transformer and its switchgear. How to make this check? Well, that depends mainly on the type transformer. If it's an oil-filled unit, treat it like the one in the primary sub. The Code requires that any oil-filled transformer be placed in a fireproof vault if inside the plant. An askarel-filled unit needs little attention other than regular temperature checks and general inspection.

Note we haven't said anything about testing the oil or askarel for dielectric strength. It's hardly necessary each month; once a year is enough in most plants. This suggested time-span may be moved in either direction, depending on the plant itself and the general condition of the transformers.

Give circuit breakers in secondary unit subs a close look. Two major items to check here are main contacts and overload trips. Where breakers are cascaded (POWER, October 1953, p 106) always inspect breakers that trip on overload before reclosing. This is in addition to any monthly or annual inspection. On the monthly visit look for signs of contact burning or overheating. Overheating is quickly spotted by a blue haze on the copper parts.

Check that machine operators, or possibly your own plant electricians, haven't jumped out the thermal trips or slipped in the next larger size, just to hold a breaker in when she should be popping on machine overload. Where the newish high-rupturing capacity fuses are used—their number is growing in motor control centers—see that they are never replaced with standard NEC fuses. I've found several plants where the good work of the distribution-system designer went for naught because the plant electrician slipped a NEC fuse in place of a high-interrupting fuse the first time she blew.

Secondary Runs. Pace along after the secondary feeders right up to the motor-control equipment. It's a wise practice to take load reading occasionally, but not as the fellow is doing above. Don't let your men risk their necks just to check on machine or feeder loading.

Use a split-core ammeter, but do it safely. Make sure you are on solid ground and standing on an insulated base. Then carefully slide the split-core into place. Compare readings with feeder size and breaker ratings.

Index arrow on green inner scale has been set at known 50% distillation point (546) of fuel on red outer scale. With inner scale held firmly in position as set above, you will see opposite the known API gravity (21.6) of fuel, on green inner scale, the cetane number of 27. This number is read on white section of the outer scale

If vendor lists cetane number of 35 here, then either API gravity or 50% distillation point would have to be different from that listed by fuel vendor's analysis report. Photo lists 50% distillation of 546. Here you'd have an API gravity of 25.7 instead of listed 21.6 to obtain cetane number 35 reading. This check takes only a minute

Assume cetane number of 35 is listed by oil vendor. Then either API gravity or 50% distillation point would have to be different. Here you see that with listed API gravity of 21.6 you would have a 50% distillation of 608 instead of the listed 546 to obtain a cetane number reading of 35 indicated. That's why you must always check

Cetane calculator: a tool for diesel

By **FRED CARTER**, *Worthington Corp*

► ONE OF OUR LATEST dual-fuel engines had passed its factory tests with flying colors. Engine was installed, and had been on oil operation for several days when I arrived to prepare her to go into "gas" operation.

I checked combustion pressures at full-load oil operation. This is a highly important adjustment because pressure balance between the cylinders must be within 20 psi. At light loads there was a smoky exhaust, but it cleared up after adjustments. I figured smoke was caused by cold weather.

Trouble. Trying to get into gas operation, the governor would open the gas rack wide. Then engine detonated, until returned manually to oil operation. This engine was equipped with dual-plunger fuel pumps. Pumps meter out 5% pilot oil for ignition when on gas operation.

Customer had ordered the fuel oil we specified for this engine so I naturally eliminated that as a cause of this trouble. I started a series of time-taking checks, including linkage settings, gas-air ratio, inlet-air system, gas system, and all other possible causes.

These deductive checks included talks with gas company, checking turbocharger, piping for restrictions, gas-metering valves, engine timing, gas-injection valve timing and adjustments. This took time and was tough on both the customer and me.

Slow Progress. During this ordeal the only way we could get into gas operation was to apply enough load to engine on oil operation to raise temperatures, then change over to gas. We did find that blanking off cold inlet air entirely and using warm plant air through an inside filter helped change-over to gas at no load. But that took unusual gas-rack opening. Even then engine detonated at 75% and higher loads.

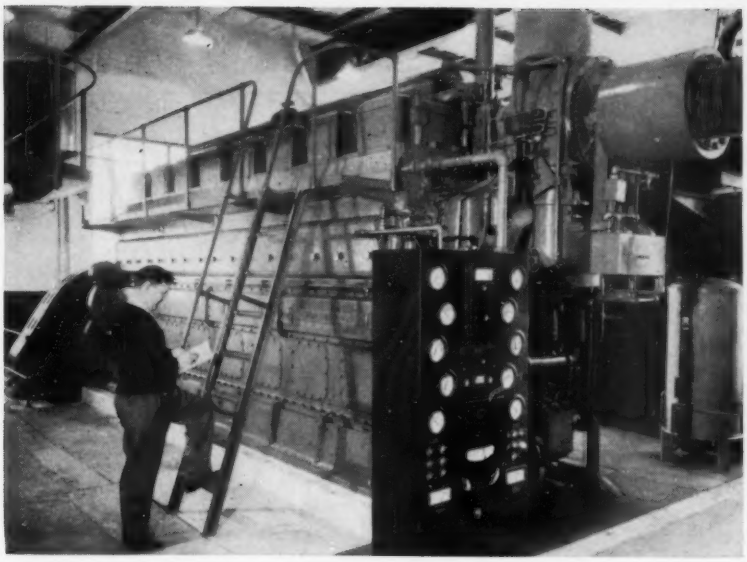
It seemed to me that air-gas ratio was not enough to support combustion, but with both gas and air checked out OK, there was nothing to do but check fuel oil again. This seemed like wasting time because oil from vendor checked with our requested specifications for cetane.

But Superintendent M D Geving, a very capable and efficient engineer, checked the oil vendor's specifications anyway. Then he happened to remember putting a cetane calculator in his files. By referring to fuel-oil vendor's analysis report he noted that the 50% distillation and API gravity figures gave a different cetane number than vendor had listed.

Oil Not Right. We called for cetane number of 45 as "recommended" and 35 as "satisfactory." Fuel-oil vendor had listed cetane number as 35, but calculator showed it to be only 27.

You only need know API gravity and the 50% distillation readings to find cetane number of any fuel oil. This information solved our problem as another fuel analysis proved calculator to be correct.

We learned another thing in this case when we tried burning the 27 cetane oil with a much higher cetane number. This blending of two oils to obtain a higher cetane fuel didn't work because



As new fuel of right cetane number came into this latest type dual-fuel engine, she purred like a kitten. Here is Superintendent M D Geving, checking her performance. Latest operating figures show that her fuel cost per kwhr is only 0.00385 mills. And engine's load factor over month's operation was an average 70% during this time. Before right fuel oil was used, the author spent many trying hours checking everything possible to find out why engine did not perform properly on gas operation. Fuel-oil vendor had listed cetane number of fuel as 35, but working out this number on cetane calculator proved oil to be only 27. Needless to say, fuel is now bought from a different vendor

engine trouble-shooter

lower cetane fuel stayed at tank's bottom where feed line to engine was located. And higher cetane oil remained on top.

Success. This resulted in the same lower cetane fuel-oil operation until the higher cetane fuel was reached. Then things really happened. As new fuel came into engine's fuel-oil inlet header, each cylinder smoothed out immediately. Fuel rack closed to its normal opening, the no-load changeover from oil to gas took place without any excessive gas-rack opening, or loss of rpm. Exhaust temperatures came back to normal and engine quieted down to normal operating sound. Full load could then be carried with no detonations or even a trace of pinging.

Needless to say, the fuel-oil vendor lost this account. Cetane calculator is now used to check each new fuel purchase. It's just a case of checking the 50% distillation and API gravity figures listed in fuel-oil analysis.

Since this experience, I always use a cetane calculator where fuel-oil specifications don't list cetane number. It takes only a few seconds to determine cetane number.

To give you a comparison of this engine's operation, here's the report for past month, with several other makes of engines at same plant. Fuel cost per kwhr:

Other makes of engines				*Our engine*
No. 1	*No. 2*	*No. 3*	*No. 4*	*No. 5*
.0125	.0075	.0109	.0090	.00385

We understand this figure of 0.00385 mills per kwhr is one of the best in the entire state, and compares very well with any engine performance in the country. Incidentally, during this same period of operation, pilot fuel oil used for gas operation amounted to 4.89% —another very healthy factor. Engine load factor over the month's operation was an average of 70%.

After such a shaky and trying ordeal at the start, I really appreciate the part played by the cetane calculator to bring this engine's performance to this very successful and happy conclusion.

Cetane number is easy to find. Ignition quality of a diesel fuel is its ability to ignite spontaneously under conditions existing in engine cylinder. Fuel with a good ignition quality (one that auto-ignites at low temperatures) is best for several reasons. Ease of starting, smoking and knocking are all related to ignition quality.

Starting. An engine will start if cylinder temperature, after compression, is above auto-ignition temperature of fuel. Since compression temperature depends on atmospheric temperature, fuel with low auto-ignition temperature helps engine start at lower atmospheric temperature.

If fuel's auto-ignition isn't low enough, engine will smoke, especially at light loads when engine temperatures are low.

Combustion knock in a diesel is believed to result from rapid burning of fuel charge accumulated during delay period between injection and ignition. The lower the fuel's auto-ignition temperature, the sooner it ignites, resulting in a shorter delay period. The shorter the delay period, the less the quantity of fuel that accumulates—less tendency to knock, smoother-running engine.

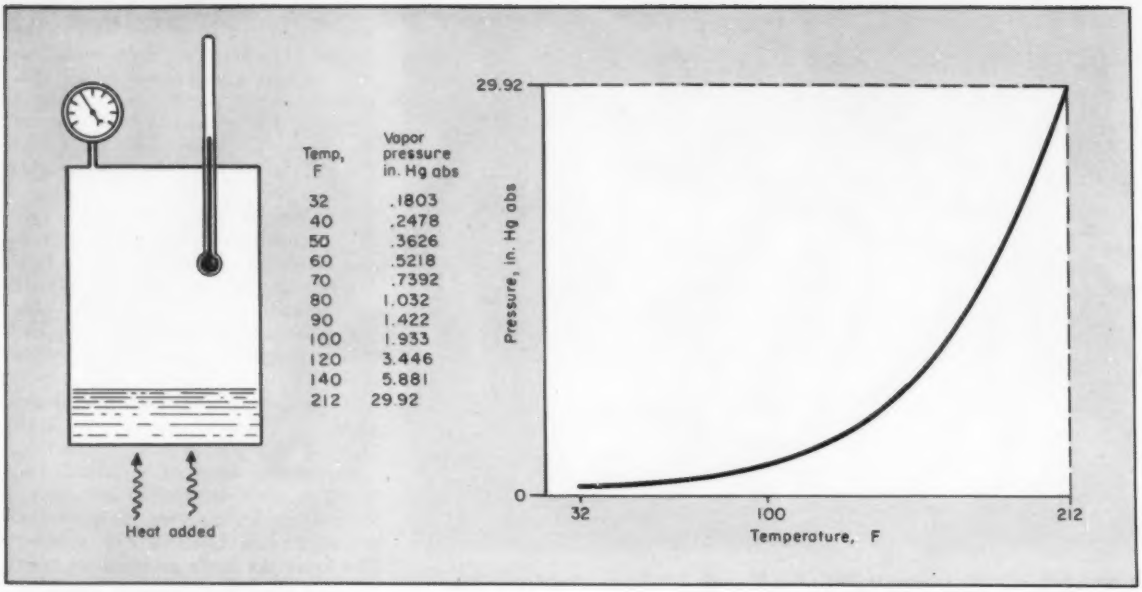
Standard-test fuels adapted for measuring ignition quality of diesel fuels are two hydro-carbon liquids—cetane and alpha methyl naphthalene. Cetane has very good ignition qualities while those of alpha methyl naphthalene are very poor, giving engine trouble.

This brings us to yardstick for measuring ignition qualities—which is the cetane number scale. On this scale, cetane is selected as 100 and alpha methyl naphthalene in standard fuel that matches ignition quality of tested fuel.

Thus, if a fuel has same ignition quality as a mixture of 60% cetane in alpha methyl naphthalene, fuel's cetane number is 60. At any rate, it's important to know your cetane number.

Did you know . . .

that diesel governors are made for engines that will change the engine speed for a given load? Speed is changed either manually at the engine or electrically by remote control at the switchboard—or other point. For variable-speed drives, the speed adjustment may permit speeds of one-half normal or less, while for most electric drives, where constant speed is needed, the adjustment is only sufficient for synchronizing purposes and for proper load distribution between units. In changing speed, the governor still functions, although the speed regulation may be impaired at lower speeds. Your engine may need one.



RELATIVE HUMIDITY is actual amount of moisture in air at any given temperature, divided by the greatest amount of moisture the same air could hold without condensation. A convenient way to look at this is in terms of pressures. That is, actual pressure exerted by moisture (*vapor pressure*), divided by highest vapor pressure possible under the same conditions, gives relative humidity. Let's look at a system that gives us the relation between this highest possible vapor pressure—the *saturation condition*—and temperature.

At left above, we have a sealed chamber with all air evacuated and water in the bottom. Now we get the system at exactly 32 F and let it settle. The pressure gage then shows 0.18 in. Hg abs. If we do the same for 40 F, the gage reads 0.25 in., and so on up to 212 F. Precise values of these gage readings for various temperatures are tabulated.

If we plot these pressures and temperatures, we get a *vapor-pressure curve, above*. For atmospheric air, this curve represents highest pressure that water vapor can have without condensation—it's 100% relative humidity. This pressure, plus that of dry air, makes up atmospheric pressure.

We often say, 'It isn't the heat, it's the

But what is humidity and how do we measure it? That's where the often misunderstood term "relative humidity" comes into the picture. To get it clear, start with explanations in the diagrams and captions, then read text to see how we find it

By **TOD WALDRON**, *Assistant Editor*

► IN THE DIAGRAMS and captions we've got a line on what relative humidity is, and on one of the items we need to measure it—saturation vapor pressure. We've also seen what wet-bulb temperature is. Now we need to know how to use wet-bulb temperature to get the other item—actual vapor pressure—involved in relative humidity.

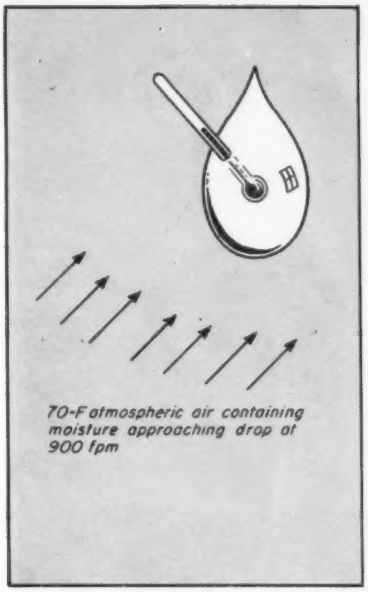
If the air were saturated (100% relative humidity), we could measure vapor pressure directly below the saturation curve. But in our example, air isn't saturated, so its actual vapor pressure is something less. As shown in the last diagram, actual vapor pressure is found under the curve at a point called *saturation temperature*. This is the temperature to which our air mixture would have to be reduced to bring it to 100% relative humidity.

To find the actual vapor pressure, we recall that at the wet-bulb temperature (*see captions*) the heat from the air to a water drop equals the heat taken from the drop to vaporize water. So we set up heat-transfer relations for each condition and put them equal to each other.

For temperatures from 30 to 130 F, this gives a simple and fairly accurate rule: Actual vapor pressure equals saturation vapor pressure at wet-bulb temperature minus 0.11 times difference in dry- and wet-bulb temperatures. Then actual vapor pressure divided by saturation vapor pressure at dry-bulb temperature gives relative humidity. We usually multiply by 100 to get relative humidity as a percentage.

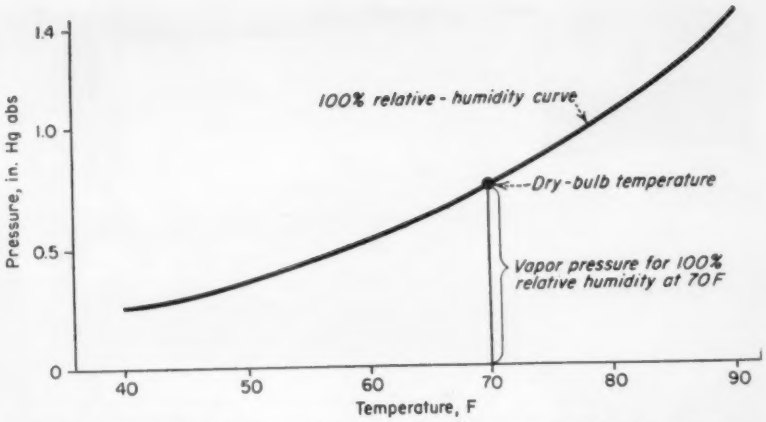
Let's see how this works for the diagram figures, taking wet-bulb temperature as 58.3 F. From the table, saturation vapor pressure at wet-bulb is 0.491 in. Hg abs. Then 70 minus 58.3 gives 11.7 as difference between dry and wet bulbs. Multiplying by 0.11 yields 0.129. Subtracting this from 0.491 we get 0.362 as actual vapor pressure.

Saturation vapor pressure at 70 F is 0.739 in. Now if we divide actual va-



ACTUAL VAPOR PRESSURE. We now know highest vapor pressure possible for air at various temperatures (*table, curve, p 128*). Let's call it *saturation vapor pressure.* For relative humidity, we also need actual vapor pressure.

We measure this by a *psychrometer.* To see how this gadget works, let's look at a water drop at 70 F, with moist air, also at 70 F, blowing on it at 900 fpm.



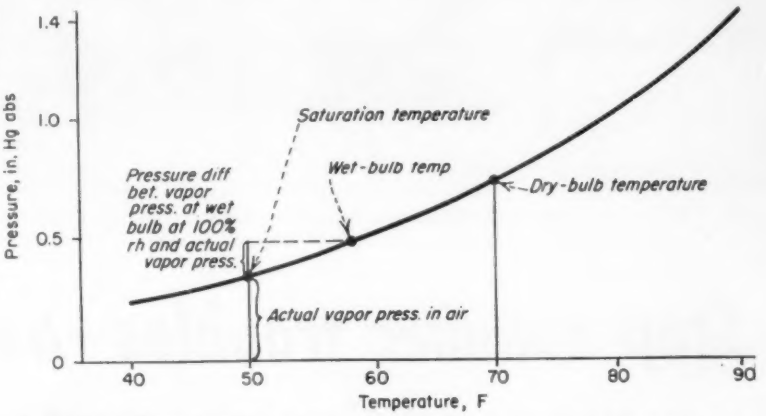
DRY-BULB TEMPERATURE. Curve shown here is a blownup reproduction of vapor-pressure curve on facing page. Water drop we've just been talking about is at 70 F, so it shows as a point on saturation curve at that temperature. Such a temperature, measured by ordinary thermometer, is called *dry-bulb temperature*

humidity'

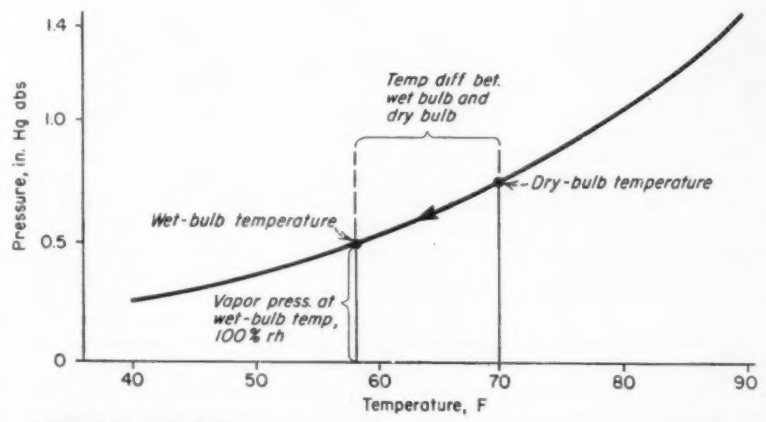
por pressure by this, and multiply by 100, we get 49% relative humidity.

Wet-Bulb Thermometer. We've seen what relative humidity is and how we can figure it if we know dry- and wet-bulb temperatures. Dry-bulb comes from an ordinary thermometer, but how do we get wet-bulb? Even if you've never seen a wet-bulb thermometer, you've probably guessed by now that it's an ordinary one with its bulb surrounded by a wick wetted with water.

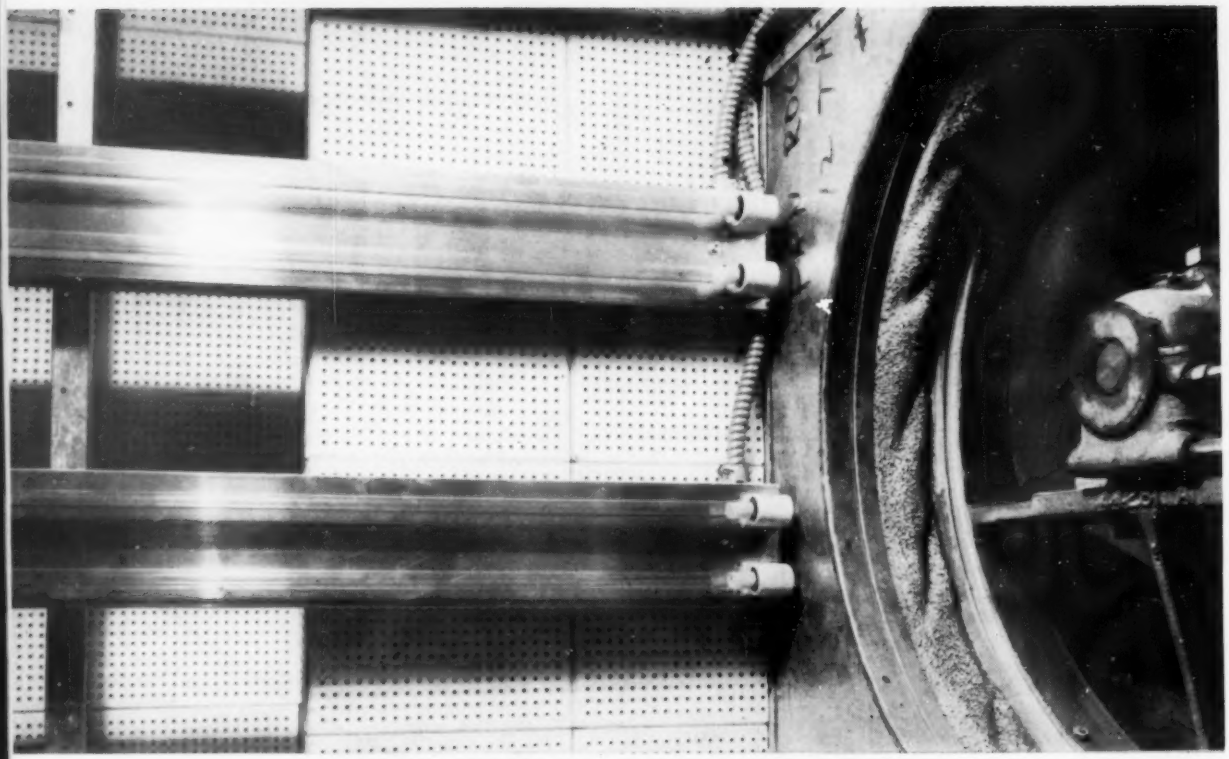
In what is known as a *sling psychrometer,* dry- and wet-bulb thermometers are mounted side by side. The instrument can be twirled around like a charm on the end of a watch chain to get air moving past the wet bulb at 900 fpm or so. This simulates the conditions of that drop of water we talked about in the diagrams and captions. Many psychrometers have a slide-rule gadget on which you set the two temperatures and read relative humidity directly.



WET-BULB TEMPERATURE. Now let's see what happens when air at 900 fpm starts blowing on the drop. Water at surface begins to evaporate. This vaporizing takes heat—latent heat of vaporization—so the drop is cooled. Temperature the drop finally reaches when cooling stops is what we call *wet-bulb temperature*



COOLING OF THE DROP stops at wet-bulb temperature because heat coming from the air to the drop eventually equals heat given up by the drop. As we'll see in more detail in the text, we can find actual vapor pressure of the air, and thus its relative humidity, once we've established the wet-bulb temperature



FAN INTAKE fitted with germicidal lamps is spotless and ready to give good service

Stop summer troubles—overhaul your air-conditioning system today

► HOT WEATHER isn't too far off in many sections of the country. That means you'll soon have calls to "turn on the air conditioning." Are you ready? You should be. Here are many helpful tips on how to overhaul your system quickly and thoroughly.

Where to Start. Talks with many operators show they *think* in terms of working from the air-intake louvers to the grille or outlet in the conditioned space. Many don't *work* in this exact order, but they organize overhaul jobs with this sequence in mind. Let's see how it works.

Air Intake. Louvers and screens collect dust, dirt and moisture during the winter months. Starting your system or unit without first removing these accumulations can be mighty embarrassing —and costly.

Wire-brush any rusty intake louvers. Then apply a good rust-preventive paint. Remove dust and dirt from the insect screen near the louvers, using a soft bristle brush. Vacuum-clean the louvers, screen and dust chambers, if you have a suitable cleaner. Incidentally, a good industrial vacuum cleaner is worth many times its cost during annual overhaul of an air-conditioning system.

Check casing around the air inlet to see that the doors are tight. Look for cracks, holes and other possible sources of air leaks. If there's a canvas connector between the louvers and casing, inspect it for holes, rips and decay. It's a good policy to replace canvas connectors every few years, even though they appear to be free of any damage.

Carefully inspect all return-air ducts that enter the casing near the main air intake. Operate dampers, watching them to see they move freely and smoothly from the open to the closed positions. Be sure the dampers close tight. Bent, dented or clogged dampers can decrease system capacity or throw system air balance out of whack.

Air Filters. Have these been renewed since last fall? If they haven't, and are the type that must be replaced, install a new set. And while you're at it, buy enough replacements for the remainder of the season. Then you won't be caught short on the hottest day of the year when complaints from people in conditioned areas just make life a little harder to take.

If your filters are the permanent type, renew the oil charge, clean the felts, or hose the elements, depending on the particular design you use. After you've finished this job, be sure to clean all dust and dirt from the floor of the casing, the filter supports, etc.

Heating, Cooling Coils. Brush and vacuum the exterior surfaces of heating and cooling coils, being certain to re-

move all dust, dirt and rust. Check the outside of the coils for leaks and corrosion. Straighten or replace bent or damaged fins.

Examine the steam-control valve and its auxiliary equipment. Poor control can lead to haywire humidity and temperature conditions during operation.

See that trap and condensate-return piping are in good working condition. If you haven't checked coil interior for several years, disconnect the coil and use a flashlight to inspect inside surfaces. It should be clean and free of corrosion.

Do the same for the cooling coil. It can develop troubles similar to those found in heating coils.

Air Washer. Start the water-circulating pump, checking its motor, impeller, casing, packing, piping and controls. Oil or grease, as required, following the manufacturer's recommendations. Be sure to have water flowing to the pump before starting it.

Inspect the water-spray nozzles while the pump is running. Rust, algae or dirt may clog nozzle openings, reducing the quantity of water passing through the washer. Remove and clean all spray nozzles that are plugged or have a defective spray pattern. Some operators remove all nozzles for cleaning before the start of the season. Though this takes a little longer, it gives you a comfortable reserve capacity that pays dividends throughout the entire season.

Check air-washer drain. If much dirt has accumulated in it, run a snake through the pipe so there is no danger of stopping during the cooling season. Lift float control, if fitted, to see that it works freely and that float is not waterlogged. Replace leaky floats—soldering or brazing is seldom satisfactory.

Inspect washer pan for corrosion. Remove all rust, apply red lead, and then paint the interior and exterior of the pan. See that electric-light fitting in the washer, if fitted, is clean and rust-free. Install a new bulb, if needed.

Eliminators. Often made of 20-ga metal, the eliminators catch moisture in the air stream leaving the washer. If left unpainted, corrosion may develop, especially at the lower ends where they extend into the water in the air-washer basin. So carefully check all surfaces of the eliminators, making certain they are free of corrosion, pits and other damage.

Straighten or replace bent or damaged eliminators. Unsymmetrical plates destroy the air-flow pattern and moisture may be carried over to the fan, causing corrosion and other troubles.

Paint eliminators after removing all rust and corrosion products. Use a good grade of rust-preventive paint.

Fan. Turn by hand several times to see that fan is free to move without rubbing the stationary parts of the housing. Inspect fan-drive motor, pulleys and belts. Lubricate fan and motor bearings.

Inspect fan interior. Clean all dust and dirt from fan blades, shaft and casing interior. Check wheel braces for tightness, if used. Open and close outlet dampers, watching to see they move smoothly and freely, and close tightly. If fan blades are rusty, paint after removing all rust.

If possible, refrain from starting the fan until the interior of all ducts running to the conditioned areas has been cleaned. This will prevent scattering dust throughout the areas—a boner that can be both costly and bothersome.

Ducts. Depending on how clean your conditioned air must be, either routine or extensive cleaning of duct interiors is necessary. Vacuum cleaning with hoses of sufficient length to run half the distance between cleanout doors is satisfactory for ordinary air-conditioning systems. Where extreme cleanliness is needed, as in process work, duct interiors may have to be dusted, washed and vacuumed.

Of course, the best answer to keeping dirt out of ducts is to fit good filters on the air intake. Then there is less chance of dirt ever reaching the ducts, outlet grilles and air registers.

Start System. Once you're sure all parts are in good working order, start the fan. Run fan for half an hour, checking it carefully for balance, excessive noise, pulsations, etc. After fan is checked out, start the spray-water pump and heating or cooling coil.

Station a man in the conditioned area to check the ducts, outlets and return-air grilles. Arrange a telephone connection between him and the fan room so he can have the system shut down should trouble develop.

Keep a running log during system start-up. It may help you locate the causes of any troubles that develop. Also, it enables you to compare performance during the cooling season with that during the initial run.

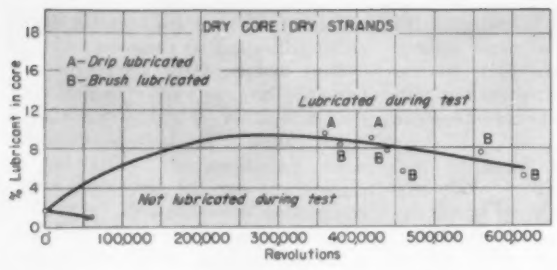
Final step in system overhaul is a check of temperature and humidity conditions in the conditioned area. They should agree with design requirements for the particular outdoor conditions existing during the test.

Of course, annual overhaul of an air-conditioning system must go beyond the fan room to the chilled-water and steam-producing apparatus. However, this phase of the work has been covered in previous POWER articles (see May, June and August, 1952).

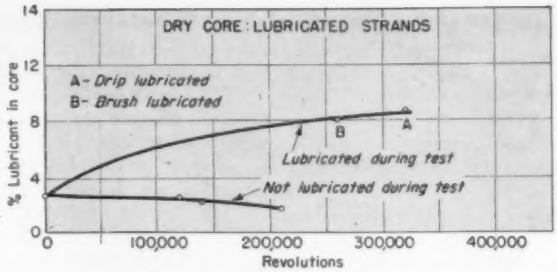
No. 5 of the Bill Eddy cartoons

Repeated by request

"According to POWER, the liner should slip right out."



1 Without external lubrication, dry-core dry-strand rope failed fast. Core readily absorbed lubricant when applied



2 This rope, similar to that at left, but made with lubricated strands, also absorbed external lubricant readily

How lubrication helps your wire

To get safer and more economical service from wire ropes, this manufacturer recommends lubrication during operation. Here's the story on how lubrication improves life of ropes

► WHEN YOU LUBRICATE a wire rope, you are helping to lengthen its life, cut corrosion of the wires, and improve the internal condition of the rope core. These are three of the conclusions to be drawn from a series of tests we recently completed. We wanted to find out just how much effect external lubrication has.

In particular, we wanted to check whether (1) the fiber core absorbs lubricant applied externally during its period of service (2) operation over sheaves and drums under tension tends to reduce the lubricant in the core (3) proper lubrication during operation materially helps maintain a better condition of the core (4) lubrication can improve a rope's ultimate life.

The tests and their results follow. But, first, a bit of background on rope cores.

New rope core generally has 12 to 15% lubricant. This is the maximum amount a core can hold when it is compacted by closing the steel strands of the rope around it. Core is further compacted by tension and kneading actions when it goes into service.

This compacting occurs during the initial period of service, while constructional stretch is being removed. Area between fibers becomes less, and core can hold only 8 to 12% lubricant.

This supply begins to be depleted as soon as the rope goes into service. The strands squeeze the core during operation over drums and sheaves, and changes in tension force the internal lubricant to the surface where it is lost through abrasion and erosion. Even if surface lubricant is not completely removed, it tends to combine with dirt and other foreign material, and in time becomes ineffective.

Our tests show that the percentage of lubricant in the cores of used ropes varies practically from the original quantity furnished to as low as 2.4%. And careful examination shows that the ropes that have rendered exceptionally fine service are always those with the larger quantities of lubricant in the core.

Comparing ropes from the same installation, where both good and poor lubricating practices have been followed, shows that applying lubricant properly during operation results in higher quantity of lubricant in the core, better condition, and improved rope life.

In other, but similar, installations marked differences in lubricating practices result in marked distinction between the two in safety and economy of operation. Where good practices are in effect, the core always contains more lubricant either because of penetration or of better retention of the original supply.

Lack of lube, or improper lubrication curtails rope life. Fiber core gets drier; individual fibers become cut and chewed; core diameter reduces to the point where it supports strands inadequately. The dry fibers absorb water and tend to promote internal corrosion. If there is no moisture, the fibers may abrade the steel wires, thus reducing metallic area of the rope.

Equipment for the tests mentioned above consists of a fatigue machine where eight different rope specimens can be run at one time. Each specimen makes 180-degree turns over a 24-in. tread-diameter test sheave. During one revolution of the machine, rope travels on and off the sheave in both directions; speed is 850 revolutions per hour.

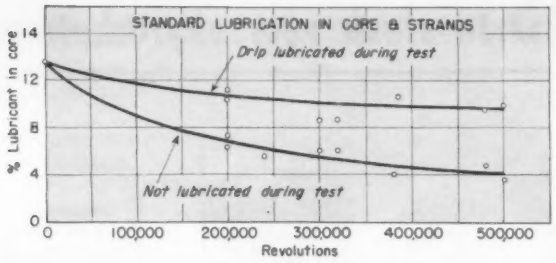
All ropes tested were $\frac{5}{8}$ in. diameter, and tension was 5000 lb. To cut the time required for testing, these conditions were somewhat more severe than would normally be encountered in the field.

Both before and after the fatigue tests, samples of the fiber cores were sent to the laboratory where extraction tests determined the quantity of lubricant present. Here are the tests and the results obtained.

Test No. 1. To check whether a rope's fiber core can absorb lubricant applied externally during service, we fabricated two lengths of special $\frac{5}{8}$-in.-diameter 6x19 right-regular-lay fiber core rope. One length was made with dry core and dry strands, the other with dry core and lubricated strands.

We used the same dry core in both ropes. It contained no lubricant except the minimum quantity of cordage oil that the manufacturer had to use in spinning the fibers.

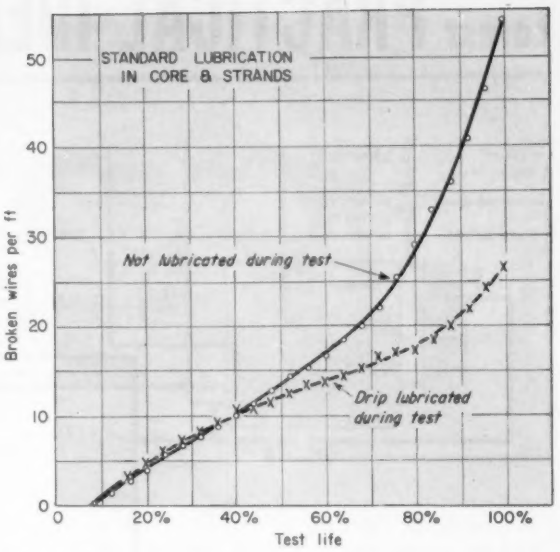
Extraction tests of this dry core before fabrication into wire ropes indicated 1.6% lubricant. Samples of core from



3 Operation under tension reduces initial lubricant in the core, but proper lubrication helps maintain core condition

rope live longer

By W I LEX, *Assistant Chief Engineer*
Wire Rope Div, John A Roebling's Sons Corp



4 Broken wires develop rapidly in unlubricated ropes, cutting down on ultimate service life you can expect to get

unused sections of the dry-core dry-strand rope also tested 1.6% lubricant. But samples of core from the dry-core lubricated-strands rope showed 2.6% lubricant, the additional quantity being picked up from the metal strands.

Next, we prepared fatigue-test samples from both reels and ran tests with and without lubrication. See charts 1 and 2 for results.

Dry-core dry-strand ropes, not lubricated during the test, actually broke after only 54,000 and 60,000 revolutions. Extraction tests on the cores of these samples showed a lubricant reduction from 1.6 to 0.9%.

But dry-core dry-strand ropes, lubricated during the test by either drip or brush methods, were not removed from the machine until 360,000 to 614,000 revolutions. Extraction tests on the cores showed a lubricant content of 5.5 to 9.3%, as compared with the original 1.6%. This indicates that the core absorbed lubricant from the external application during the test.

We tried several types of lubricant. For drip application, we used a fluid petroleum oil of 77.5 ssu viscosity at 210 F. For brush application, we used heated lubricants of the following types: petrolatum lubricant with 106-F melting point and 334 ssu at 210 F; semi-fluid grease containing 1.2% soda soap; petrolatum with 150 to 165 F melting point and 110 to 130 ssu at 210 F; a mixture of 50% of the above petrolatum and 50% of SAE number 70 mineral oil.

Dry-core lubricated-strand ropes (chart 2) run without external lubrication, showed some improvement over dry-core dry-strand ropes. They did not have to be removed from the machine until 120,000 to 209,000 revolutions. Extraction tests showed that core-lubricant content had dropped down to 1.8 to 2.2%, compared with the 2.6% originally present in these cores.

Ropes lubricated during the test by either drip or brush methods were removed after 260,000 and 320,000 revolutions. Their cores showed lubricant content of 8.1 and 8.7%, compared to the original 2.6%.

For this test the fluid petroleum oil was used for drip lubrication, and the petroleum for brush application.

Results point out again that fiber core of a wire rope will absorb lubricant applied externally during time of operation.

Tests No. 2 and 3. To check whether (1) operation over sheaves and drums under tension tends to reduce the lubricant in the core, and (2) proper lubrication during operation materially helps maintain a better condition of the core, we used a standard $\frac{5}{8}$-in. 6x19 blue center-steel regular-lay fiber-core rope. Core and strands had been manufactured in the regular manner, and extraction tests showed 13.5% lubricant in the unused rope core.

We made two series of tests, using eight sections of rope for each. The first series was without lubrication, the second with it. At intervals ranging from 200,000 to 500,000 revolutions we removed samples from the machine.

In the unlubricated series, the lubricant remaining in the core varied from 7.3 to 3.4%, as compared with the original 13.5%, (chart 3).

In the second series, we drip-lubricated the specimens with fluid petroleum oil. Checking the fiber cores at the same intervals as above showed that lubricant ranged from 11.2 to 8.6%.

This series of tests indicates that lubrication during operation will not maintain the percentage of lubricant originally in the core, but the core will absorb some lubricant and stay in far better condition than without lubrication.

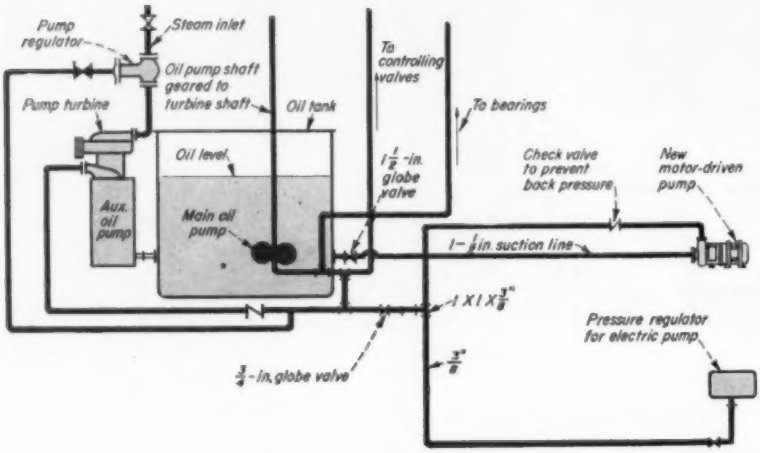
Test No. 4. To check the question of whether external lubrication during operation improves ultimate rope life we again used two sets of rope from a standard reel. The first test was without lubrication, the second with drip lubrication as above.

At every 20,000 revolutions we inspected all ropes, counting all broken wires. When more than 50 broken wires had developed in one foot of an unlubricated rope, we removed it from the machine. In both tests, this interval was taken as 100% test life for the rope in that same position on the test machine. Chart 4 shows the results.

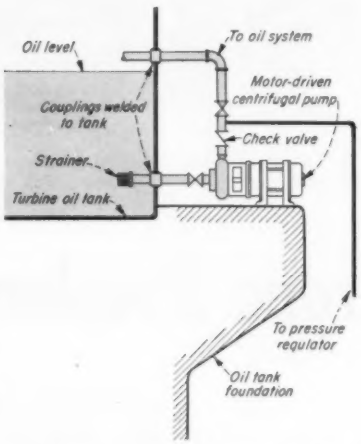
The curves are average figures for the eight ropes in each test. At the end of the second run, we found only half the number of broken wires in the lubricated ropes, as compared with the unlubricated ropes in the corresponding positions.

(*Continued on page 248*)

Latest PRACTICAL IDEAS to slash your skyrocketing



1 New hookup is set to start when oil pressure drops to 30 psi, stops at 55 psi



2 Pump now has positive head as shown

Now! New Pump Cures Sunday Headache

SUNDAY USED TO BE a problem until we replaced our turbine-driven auxiliary oil-pumps with electrically driven units. During the workweek we operate a 3500- and a 5000-kw electric turbine. But on Sundays and holidays we shut down and run with diesel-driven 300-kw generator.

Our Sunday problem was cooling two big turbines after shutdown. They normally run on above-800-F steam, storing considerable heat in turbine metal. While the turbines are running, heat is automatically dissipated by main oil pumps, which are geared to the main turbine shafts. But after shutdown, a large quantity of heat was left which had to be dissipated before metal could cool to room temperature.

Turbines are so heavily insulated that radiation alone is not enough. To prevent overheating we must run auxiliary oil-pumps about six hours after shutdown. Otherwise, heat stored in bearing housings and babbitt linings of bearings would dangerously overheat.

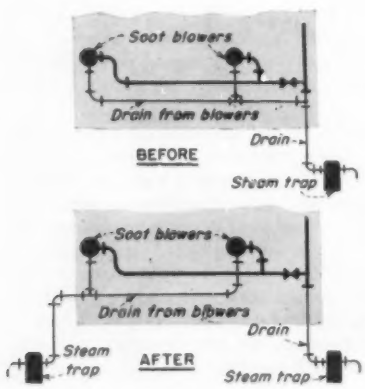
Each turbine originally had a turbine-driven auxiliary oil pump and pressure regulator. These auxiliary pumps raise oil pressure in system to open controlling valve before starting turbine and supplement main oil pump when turbine is idling, starting up and shutting down. Pressure regulators automatically start pumps when pressure is low and stop them when high enough.

To run these auxiliary pumps after shutting down large turbines, we had to keep a boiler going for the six hours needed to keep bearings from overheating. Pressure regulators and pumps also gave minor troubles then. So we installed motor-driven pump to each main turbine, leaving turbine-driven auxiliaries as emergency standby units.

Fig. 1 shows new installation. Bourdon-type pressure regulator is adjusted to start electrically driven pump when oil pressure drops to 30 psi and to stop it when pressure rises to 55 psi. To prevent pump shutting down itself, we set regulator's high pressure cutout to 5 psi above normal pressure developed by electric pump. Main oil pump also develops 55 psi.

By giving new pumps a positive head, Fig. 2, we also improved operation.

J R BROWN *Bauta, Cuba*



Good Drainage Saves Our Boiler Tubes

ONE OF our 2-drum boilers has three blowers crosswise and two in front under headers. Blowers are used three times each 24 hours.

One day we heard a hissing sound in the furnace. In tracing, we found the seventh inclined tube on bottom row punctured, so we shut down the boiler.

In replacing the tube, we saw the sixth tube, adjacent to repaired one, was badly grooved. It had a bright spot like filed metal, about same distance from header. Testing bright patch with a light hammer gave a dull sound. Four feet away the same tube again gave the same ringing sound. It was so badly thinned that it collapsed when hit harder. We noticed that most tubes blown with that blower appeared white in color instead of the usual black for a distance of 7 ft from header. Tubes blown by right-side blower were black.

We replaced this tube also. After two weeks of steaming, the hissing started again. After cutting out the boiler, we found a third tube adjacent to the two new tubes punctured. And point of failure again was two feet from headers,

not exactly above fires, but on one side between tubes.

Maximum shooting effect of blower corresponded exactly with punctured area. This blower is worked by a hand wheel, which first throws nozzle forward and then opens steam jet that moves radially. All three punctured tubes were in line and above line of steam jet in direction of shooting angle.

That placed blame on blower. Superheated steam is used in these blowers, so I concluded that trouble was from faulty draining. Drains were connected as shown in top sketch. Our combustion gases contain sulfurdioxide (SO_2). When mixed with water it turns into sulfuric acid, H_2SO_4. After changing drains as here, trouble was solved.

P R JAYAWANT *Dhantoli, India*

Here's Handy Roll-Pry Bar

PRY BAR in sketch can be used with a roll bar, which is very handy for moving heavy work. In handling, operator becomes quite adept in steering the work while it is moving. Short roll is directed right or left at will. Bar can be used without the roll for direct pry. I find that a couple of these bars and a regular crowbar with a few strong hands will move a sizable load into position.

C H WILLEY *Penacook, N. H.*

What Would You Have Done?

AS MAINTENANCE ENGINEER for a large lumber firm we had many cranes with vertical firetube boilers. One of our big cranes was working around the clock loading a rush shipment of lumber. About 2 am I was waked up because the fire in the crane's boiler had been put out by a leaking boiler tube.

Steel caps that fitted at each end of a tube were held tight with a rod. But to get one of these plugs in the fire end of a tube meant pulling the fire and cooling the boiler down so a man could get inside and set the cap. I felt that if I had to shut down and cool the boiler, I might as well roll in a new tube. But this was a cold night and we needed that crane badly.

I had murder in my eyes when I arrived at the mill. My teeth chattered, and my only thought was to get back to my warm bed and go to sleep. So I used an old trick I learned at sea. I whittled a soft pine plug to a snug fit and drove it into the leaky tube until the water stopped flooding the firebox.

The plug would char at the ends. But I knew it wouldn't burn as water leaking through the leaky tube would wet it again as fast as the moisture evaporated. I was back in bed a few minutes later and forgot about that boiler until I had a chance to shut it down during our slack season. What would *you* have done?

BILL DAVIS *Des Plaines, Ill.*

Scotch Tape Keeps Pencil From Rolling

PENCILS always roll off a slanted drawing board. I also have same problem when trying to keep pencil on typewriter stand. There, typewriter vibrations causes pencil to drop off unless it is tied to stand with a string.

My solution is to place a short piece of scotch tape around pencil's end, photo. Tape is not in way and pencil stays exactly where it's placed.

D B CLAPP *Irvington, N. J.*

(*Continued on page* 136)

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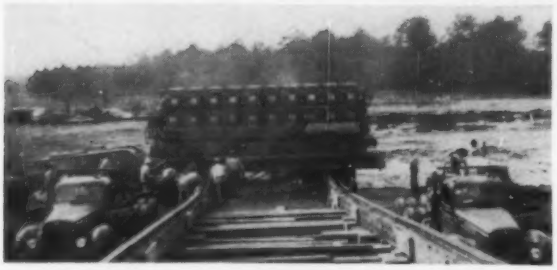


Ramp Helps Raise Heavy Engine to Foundation

PHOTO SHOWS how we moved a large 10-cylinder engine to its foundation. We built ramps same height as truck carrier-platform, and then gradually sloped them up to engine foundation's height. Heavy skidding has wood runners. Greased runners allow engine skidding to move easier.

Trucks on either side of ramp cribbing provide motivating power through steel cables at each end of engine skidding. Usually power is from winches that are standard equipment on this type transport truck. Transport for this work, known as a lowboy, is a rugged multi-wheeled vehicle for very heavy loads, built low for loading and unloading. It is pulled by a truck.

This method of moving heavy equipment is only one of many. At times, the engine is placed on a foundation and then the building is erected. Usually, engines are moved through large doors or through building walls.

Perhaps the most common way is to crib up to required level and then place wide flat runners on top of cribbing leading to foundation. Either wood or steel pipe rollers are then installed between engine-skidding and flat runners, and engine is moved in place on rollers. While somewhat slower, this method gives better and more complete control of equipment when in motion.

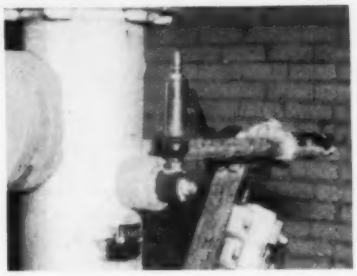
Cribbing material used and its placement are important. I recommend railroad ties for cribbing. But it *must* be placed to *insure a solid* roadway. This is one phase of operation you cannot economize on as each tie has to support its share of weight. The closer the cribbing is spaced, the more solid and dependable the setup.

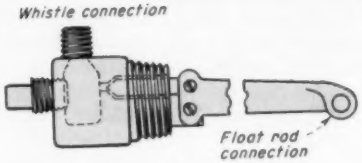
Where a railroad siding is alongside a plant, it is only necessary to crib from flatcar to plant door. Once inside the plant, check bracing of flooring the equipment is to pass over en route to its foundation. Often you have to crib or support sections of flooring.

Usually engine's foundations are adapted with jacking cutouts in either side to allow jacks to remove skidding and lower engine over foundation bolts and onto sets of shims and wedges on foundation tops. This also depends on good, well-placed cribbing for safer lowering of engines to their foundations.

Always use extreme caution when moving heavy equipment. The cribbing part of the job is the most important.

F CARTER *Buffalo, N. Y.*





No Shutdowns Now

THIS IDEA may save an unnecessary shutdown on boilers that don't have shutoff valves to water columns. High-low-water whistle valves may become plugged while boiler is in operation. Then you have to shut down and cool boiler to remove whistle valve for repair. By drilling and tapping hole for a $\frac{3}{8}$-in. pipe plug on end of whistle valve body, we eliminated these shutdowns.

If whistle doesn't operate properly, remove plug and clean the two valve orifices with a stiff piece of piano wire that has sharp edge. Before replacing the plug, blow down column so whistle valve opens and blows steam through low-water orifice. That cleans out scale particles that have been loosened.

By opening and closing column blowdown valve a few times, the water will surge high enough to cause high-water valve to open and blow out this orifice.

IMPORTANT: After cleaning, be sure to replace plug, or whistle won't work because steam will pass out of clean-out plug instead of through whistle.

C TRETINYAK *Rochester, Minn.*

Warning Collar Saves Lead-Seated Valves

WE SAVE maintenance dollars by placing this warning on valve wheels of lead-seated valves. Bright red and green letters printed on a yellow background caution operators against damaging lead seat by using too much "beef." Disk is laminated with plastic, making it flexible and keeping it clean.

Courtesy, Du Pont Petroleum Chemicals Division

EDITOR'S NOTE: *Same idea is often used on other type valves by filing notch on valve wheel showing closed position.*

Now Safety Valves Are Tested From the Floor

A PULL-CORD now makes it easy for us to test safety valves from our boiler-house floor. Safety valves on boilers are on top of front header, about 27 feet above floor. It was very awkward to get to them for daily testing or trying out.

I ran a line from the safety-valve lever over a pulley we attached to the steel structure of roof. Other end of line came down to floor. Now, our operators have no trouble testing safety valves daily.

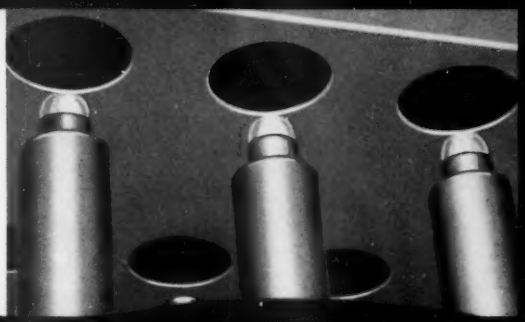
DUSTY JENNINGS *Sarnia, Ont., Can.*

(*Continued on page* 138)

4 reasons why G-E vertical-lift design is best for metal-clad switchgear

1 Allows you to see breaker disconnect

With General Electric's vertical-lift breaker, you can actually *see* that the circuit breaker is disconnected. You don't need to depend on an indicator and when the breaker is disconnected, mechanically operated shutters in metal-clad switchgear automatically close off these stationary disconnect openings to protect the operator.



2 Simple to inspect and maintain

While G-E breaker is still in the compartment, you can make most check tests and even perform some maintenance. Although removal of breaker element is relatively easy, inspection in the compartment saves considerable time and effort.

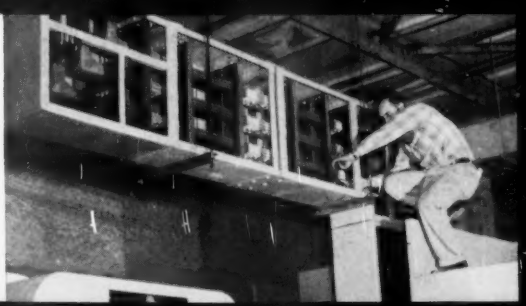
3 Saves time and energy

In G.E.'s vertical lift design air circuit breakers rated 100 MVA and larger are lowered and raised effortlessly by a simple, fast-acting elevating mechanism, consisting of two jack screws and a sturdy, compact gear-motor. You do away with jacking and cranking. Just set switch for "raise" or "lower" and hold clutch lever forward until breaker is in position.

4 Assures maximum safety

When you need to work on a feeder, you want to be sure that the breaker is disconnected. With G-E vertical lift, you can lower breaker until you *see* contacts disconnect, padlock the mechanism so breaker cannot be raised, and close compartment door. You can then work without fear that someone will carelessly close the breaker and energize the feeder.

General Electric Company, Schenectady 5, N. Y. 511-1

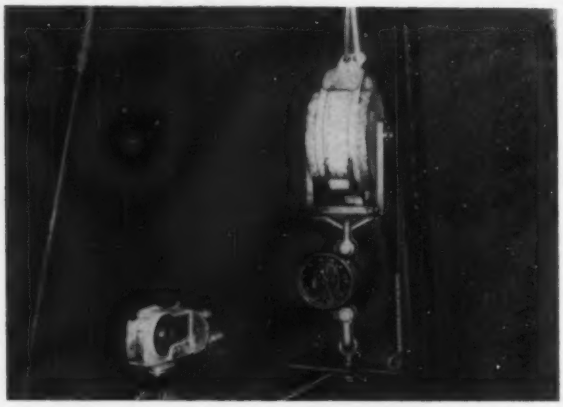


Progress is our most important product

GENERAL ELECTRIC

More PRACTICAL IDEAS

Begins on page 134



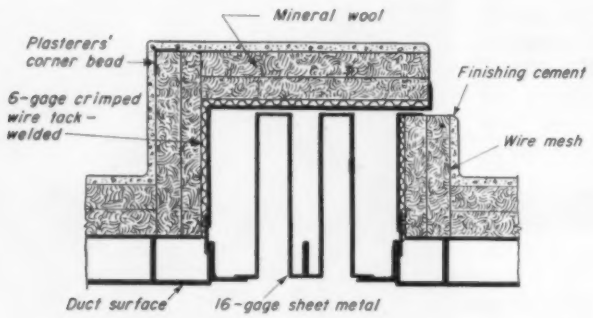
Test Safety Belts for Strength and Breakage

NOT ONLY can safety belts be tested for breaking point and amount of kinetic energy absorbed, but cumbersome and time-wasting equipment can also be eliminated.

Hoist suspended from tripod exerts a pull against safety belt positioned around drum. Drum, in turn, is bolted in series with dynamometer, entire assembly being anchored to base of tripod. Drum simulates pressure caused by a man's body against safety belt.

Steel tape is fastened at anchor point, attached to top of tripod by a wire. Slow-motion camera, *lower left of photo*, records both poundage of dynamometer dial, as tension is increased, and tape's extension, as pull is exerted to stretch safety belt. This provides an accurate reading of the kinetic energy expended against the belt, also ability of belt to withstand shock, as well as actual breaking point.

R R DILLON *Van Nuys, Calif.*



Bellows-Type Expansion Joint Prevents Damage

DRAWING SHOWS cross section of a bellows-type expansion joint installed on hot air ducts. Bellows are designed to close in more than five inches (range depends on bellows dimensions) without placing stress on insulation or finish. By eliminating chances of expansion cracks, there's little need for inspecting or maintaining insulation. Besides, joint is entirely covered with insulation at any position of bellows.

Two layers of 1½-in.-thick mineral-wool block insulation are applied to expansion joint on these 500- to 613-F preheat air-ducts. Over flat duct surface, 6-gage crimped wire is spot-welded to stiffeners, spaced at 30-in. intervals along duct. Then ¼-in. steel rods are run parallel to duct axis between stiffeners and crimped wire at about 6-in. intervals. Each rod length is welded to crimped wire at only one end to allow for expansion. Two layers of 1½x18x24-in. mineral-wool blocks are staggered and wired individually to the rods.

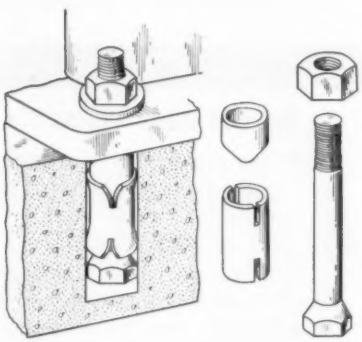
Crimped wire is tack-welded over sheet-metal skirt, at about 24-in. intervals along expansion joint. Insulating blocks are held on skirt surface by wire, tied to crimped wire between blocks. A ⅜-in. layer of mineral-wool finishing cement, covered by a coat of asphalt mastic, is applied over 1-in. wire mesh on all exposed insulation surfaces.

H W SMITH *New York, N. Y.*

Handling Drums Safely

ROLLING large drums down ramps is always dangerous, but one person can handle them safely, as in this sketch. If there is no one to help you, tie ends of two ropes near top of skid, pass under and over the drum, pull on free ends. Friction of drum against ropes makes it easy to retard drum's pull down ramp, making handling safe.

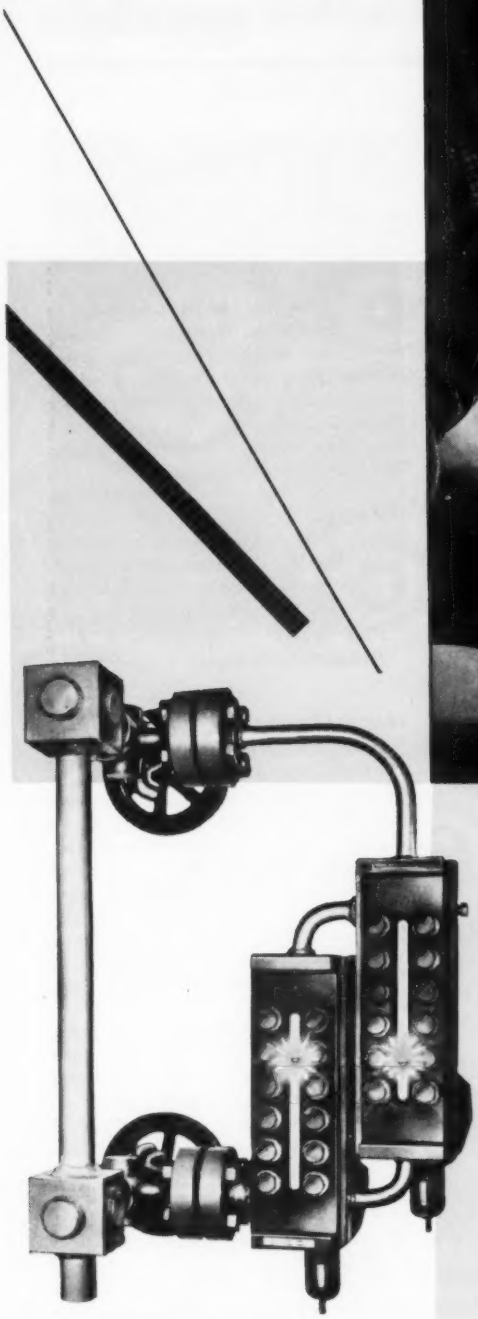
NATIONAL SAFETY COUNCIL



Foundation Bolt Fastener

HERE'S A WAY to secure machinery in drilled concrete holes. From iron pipe, we made expanding sleeves shown. Bolts were tapered under head as shown. In a pinch, you can make these from materials at hand and save a lot of work.

C H WILLEY *Penacook, N. H.*



Yarway High Pressure Boiler Water Gage with separated-design flat glass inserts. Write for Yarway Bulletin WG-1812

HE'S A SPECIALIST ON STAINLESS STEEL INLAYS

● A dentist? No.

He's a Yarway craftsman. In the picture above he is milling a gasket groove in the stainless steel facing that is used for this important part of a high pressure boiler water gage body.

The man is important; so is the inlay.

The man is typical of the skilled workmanship that goes into every Yarway gage, blow-off valve, steam trap or other product —workmanship that makes no compromise with quality.

The stainless steel facing is typical of advanced Yarway engineering design. That inlay is but one of twelve basic improvements made in Yarway high pressure water gages.

When buying boiler water gages as well as other steam plant equipment, measure the cost in terms of good engineering, quality, workmanship, and dependable service.

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EXPANSION JOINTS
DIGESTER VALVES
STEAM TRAPS
STRAINERS
SPRAY NOZZLES

PLANT PROBLEMS... *practical readers give advice*

VACUUM-CLEANING hose run in stack cleanout door removes soot, dirt efficiently

How can we clean our plant stacks?

HERE ARE THE FACTS: Our industrial power plant has two stacks —one steel, the other radial brick. Both are 180 ft high and have an ID of 8 ft at the outlet. Each is equipped with a collector.

Recent inspections of the stacks show the interiors are dirty. The walls have a thick coating of soot from top to bottom.

How can we clean the insides of these stacks? What is the best cleaning method? Is any rigging or staging needed for the job? If so, what is the safest way of setting it up? How long does it take to clean stacks of this size? Is there any difference in the cleaning of radial brick and steel stacks?—*GG, February Power*

Here are the answers

OUR EXPERIENCE shows that power vacuum cleaning of stacks is the best solution to the soot problem. Its advantages include (1) good clean stack surfaces and breechings with a minimum of effort (2) fast cleaning, minimizing plant outage (3) no air pollution during stack cleaning, and (5) low costs. Since this work is usually done by a firm specializing in it, no plant labor is needed.

As photo, *above*, shows, vacuum cleaning of stacks is usually done by running a suitably sized reinforced rubber hose to an opening in the stack or breeching. Air is drawn inward from the top of the stack at a high velocity (up to about 90 mph, depending on stack diameter and air-flow rate). During passage through the stack the air dislodges soot, flyash, cinder and other accumulations from the interior. These fall to the base where they enter the hose and are discharged to a collector, *bottom photo, facing page*.

This cleaning method is successfully used for stacks in industrial, hospital, hotel, apartment-house and institutional plants. Only two men are needed for the work. They can clean the stack any time during the day or night when the boiler is shut down.

Soot and other materials drawn from the stack or breeching are discharged by the truck-mounted vacuum pump to a large canvas bag or to a series of truck-mounted filter interceptors. The interceptors find greatest use in areas where there is not enough room to temporarily mount the 30-ft-long canvas collection bag. Soot removed from the stack is disposed of in a city dump or elsewhere.

Since the majority of equipment for this service is truck mounted, there is little bother to plant personnel during stack cleaning. Vacuum cleaning usually proves superior to washing down and mechanical cleaning of stacks.

PHIL BERLIN *St. Albans, N. Y.*
Power-Vacuum Corp

SANDBLASTING is excellent for cleaning interior surfaces of unlined brick stacks. For unlined steel stacks, sandblasting is suitable if care is taken to prevent erosion of the steel. The coefficient of adherence between the soot and stack may be so high that some steel is removed with the soot. This condition is more acute at the stack outlet where the steel may be corroded and weakened by condensation of SO_2. In brick stacks, care must be exerted not to remove the bonding mortar.

Photos, *right*, show typical work clothes to protect personnel while they are inside a stack. Safety is of prime importance in this type of work.

Gunite or a similar lining is good for stack interiors because the adhesion of soot is less than with bare brick or steel. Cleaning of stacks lined with gunite or other materials is best done by firms specializing in this type of work.

Motor-driven brushes can remove soot after it has been treated with a suitable chemical to reduce the bond with the stack interior. More time is needed than with sandblasting and the entire job may be more expensive because a larger number of men are needed.

When the opening at the base of the stack is large enough, staging can be erected to extend to all parts that must be cleaned. Or a bosun's chair or ship's ladder can be suspended from the top of the stack.

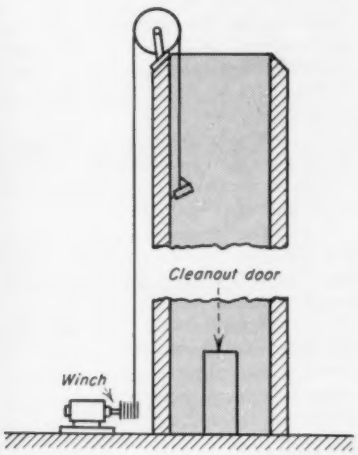
Time needed to clean the interior of

on cleaning stacks, reconnecting dc generator

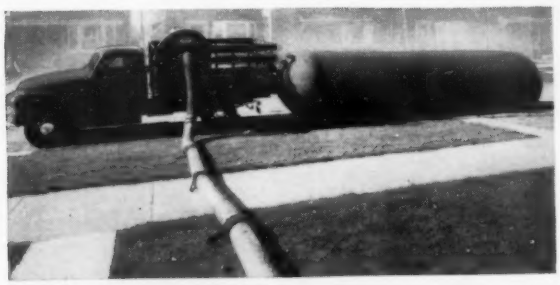
TYLER HICKS, *Associate Editor*

HOOD protects operator in sandblast

SAFETY belt, boots good on stack job



FITZPATRICK has this setup in his job



CANVAS BAG, *top,* or filters, *bottom,* hold dust for disposal

a stack will vary with the thickness of soot deposit, degree of adhesion and climatic conditions. At low temperatures the bond between soot and stack is stronger, making removal more difficult. With other factors equal, sandblasting is about the cheapest and fastest cleaning method available. Stacks the size of *GG's* can probably be cleaned in about three days, not counting the time needed to erect staging or ladders. Bids from several contractors will help *GG* determine which is the most economical cleaning method for his plant.

H B WAYNE *Brooklyn, N.Y.*

OUR SOLUTION for this problem was worked out during the war when manpower was short. Since then several other plants have copied it with success.

As sketch shows, we attach a pulley bracket to top of stack. A cable runs over the pulley and into the stack where it is attached to a wooden scraper. The other end of the cable is run to the drum of a motor-driven winch at the bottom of the stack.

To clean stack interior the scraper is raised and lowered at a speed of about 2 ft per min. We check the condition of the stack interior by watching to see how much soot falls to the base during upward and downward travel of the scraper. We run scraper until there is little or no soot falling to stack base. When one vertical strip is clean, we shift the position of the pulley bracket to clean the next strip. Resetting the bracket five or six times is all that is necessary to produce a clean stack. Of course, number of shifts needed depends on stack diameter and scraper size.

As worked out by us, the scraper is made of 4x4-in. oak blocks mitered and bolted together. Ordinary street brushes, 16 in. long and 5 in. wide with a 6-in. bristle are bolted to the mitered oak scraper.

Since the brushes are mounted in hardwood blocks, they cannot be bent by soaking or steaming. So we cut each brush into pieces 2 in. long, mitered them, then bolted them to the scraper block. We found that a radius of about 5 ft was best for the scraper. Since the hardwood is heavy, good contact is maintained between stack side and the

More PLANT PROBLEMS

Begins on page 140

brushes. We tried wire brushes but they were too stiff, became packed with soot and required frequent cleaning. Flexible street brooms will not damage mortar joints or scratch stack surface. Scratches are objectionable because they provide a place where soot may lodge.

Greatest soot deposits in our plant occur opposite the stack breeching entry. From here they gradually taper off as we go higher in the stack.

It takes a day to set up and remove this rig. Two men do the work, one at top of stack and other at the winch. The winch operator checks soot fall and signals the man at the stack top when the pulley must be shifted. Our soot deposits require three round trips of the scraper for each segment of the stack. Entire job takes about three and a half days.

We continually check stack performance by taking draft and gas-temperature readings when the boiler is operating at full load. We also check stack damper adjustment because it is another good indicator of the available draft. Keeping a permanent record of the damper opening will show the loss of draft from the soot deposits faster than any other method will.

L W Fitzpatrick
Jefferson City, Mo.

AIR, STEAM OR WATER hose is suitable for removing *GG's* stack carbon. Powdery deposits are successfully removed by air or steam. Where bond between carbon and stack is strong, water and wire-brushing may serve well. Pressure of air, steam or water should be 100 to 150 psi, depending on how difficult the removal of the soot is.

J H Riviere *Santa Fe, Argentina*

MOST EFFECTIVE METHOD uses high-pressure-water hoses to remove soot from stack interior. We use two steel painter's hooks to suspend one man and the high-pressure hose from top of stack. For safety, hose operator should wear dust-tight goggles and a mask.

A A Hunnewinkel *Woodstock, Ill.*

THIS PROBLEM appears to be confined to industrial plants burning low-grade fuel oil. I've seldom heard that utilities burning coal have this trouble.

Soot build-up in stack can be so great that there is an actual bridging of small-diameter areas, increasing the resistance to gas flow. Draft losses go way up, causing troubles in boiler operation. My experience indicates that metal stacks have more soot build up, especially when boiler is oil-fired and runs on-off in areas with wide variations in atmospheric temperature.

Brick-lined metal stacks can be cleaned with a caustic solution that is strong enough to inhibit any acid in the soot deposits. But studies show that where a stack is mounted on plant roof or other inaccessible areas, washing down may be extremely costly because provisions must be made to dispose of the wash solution without damaging nearby plant equipment. Most engineers faced with difficult wash-down conditions use mechanical means to remove soot.

Stacks mounted on the ground are easier to clean, and a caustic solution or just water may give good results. Much depends on the nature of the soot, surrounding conditions and equipment available to the engineer.

Soot deposits can be dangerous. Large accumulations at the base of the stack or in the stack itself may suddenly ignite and burn at high temperature. Though this is one way of ridding the stack of soot, it is far from safe and can lead to costly fires in plant or equipment.

Where gas discharges from the stack at high velocity, soot deposits are seldom a problem because there is little chance of particles settling out. There is little soot build-up at stack base, eliminating the cracking that is sometimes seen in concrete stacks and the spalling in brick structures.

Of course, base of every stack should be fitted with a cleanout door so soot accumulations can be easily removed. If *GG* does not have a cleanout door he should fit one large enough for a man to enter. The bigger the door, the easier the removal of the soot.

Don Kelland *New York, N. Y.*

OVERLOADED BOILERS cause two troubles in the average plant: (1) excessive soot deposits, and (2) stack temperatures higher than stack is designed for.

Soot deposited during overloads can be especially troublesome because the quantities may be large. Of course, much depends on the fuel and the way it is fired. So *GG* may find his most effective removal method is outside the stack; that is, get at source of soot and eliminate as much as possible from the flue gas before it enters the stack.

Excessive stack temperatures lead to vertical cracks in concrete chimneys,

(*Continued on page* 228)

Can we reconnect a dc generator?

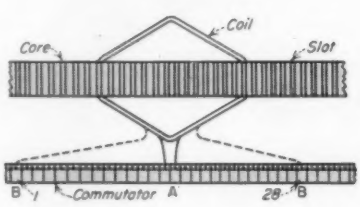
HERE ARE THE FACTS: We have a 120-v dc generator that we'd like to use for a group of new motors we intend to install. These motors will be 240-v dc.

Generator has four poles with 56 coils in the armature and 56 segments in the commutator. Coils are grouped in a 4-circuit winding.

How can we regroup the field and armature coils to give the higher voltage? Will the generator give satisfactory output if we make such a change? Will output be affected in any way? What can I do if the field coils are now in series?

Since we are doubling the voltage across the brushes, do your readers think we will get flashovers? ***—JS, February Power***

Here are the answers



REGROUP the armature coils into a 2-circuit, or series winding, and it will develop double the present voltage with the same field density, or 240 v. As the coils are now grouped, the leads of each coil are connected into adjacent segments, as shown at *A* in the sketch.

(*Continued on page* 144)

THESE 3 SUN GREASES WILL DO 95% OF YOUR GREASE LUBRICATION JOBS

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FIBROUS • Sun Grease 844X

Has exceptional oxidation stability under high temperature conditions. Recommended for all antifriction bearings. A general-purpose, high melting point lubricant for pressure gun and grease cup application.

BUTTERY • Sun Grease 300A

Especially designed for pressure lubrication of bearings operated at normal speeds and temperatures. Can be used in pressure guns, compression grease cups, or pressure lubrication systems. Has high water resistance and excellent pumpability at low temperatures.

TACKY • Sun Grease 897

For open gears, chains, slides, cams, linkages and bearings. Used whenever "throw-off" must be avoided. High adhesive and cohesive characteristics. An excellent lubricant that is water resistant and does not need frequent application.

Of the 81 different Sun greases, these three can fill the vast majority of your needs. And lubrication simplification like this means worth-while economies for you in several directions. You can reduce the total amount of money you need to "invest" in lubricants. You can greatly lighten the housekeeping job of storing and handling your greases. And you can reduce the confusion and risk of error often created when personnel are required to choose from a large number of greases.

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More PLANT PROBLEMS

Begins on page 140

Fifty-six coils cannot be connected into a series winding, but 55 coils can be. So *JS* will have to leave one coil dead in the winding and connect two of the segments together. Coil leads will then be connected to span 27 segments, or from 1 to 28, as at *B* in the sketch on page 142.

To have the field coils operate on the new voltage, they must be rewound with the present weight of wire of one-half the cross-sectional area, if now in series.

HOWARD SMITH *New York, N. Y.*

RECONNECT the armature coils to double the number of conductors in series. Then make any necessary changes or adjustments in the shunt field. Same shunt field can be used by inserting a suitable fixed resistance to keep the maximum current at the same value. However, changing the field coils for the higher voltage will be better since using the fixed resistance decreases generator output slightly and requires added equipment.

If the generator has series and commutating fields, they must be adjusted for the lower line current. It would probably be better to install new coils of a size the generator builder recommends. A new shunt field would most likely be included with the series field.

I do not think there is much possibility of flashover at the commutator. But *JS* should check with the generator manufacturer before he finally goes ahead with this electrical work.

C O VON DANNENBERG
Brooklyn, N. Y.

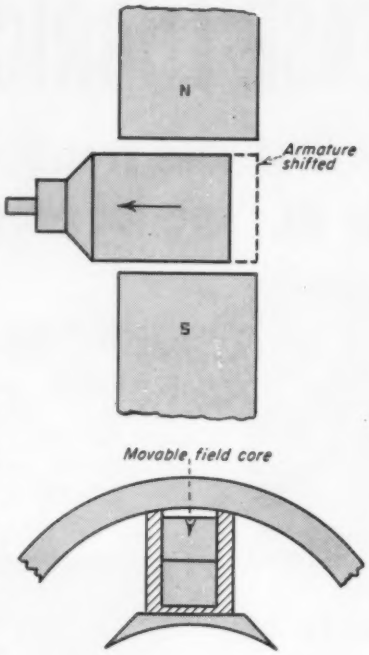
BUY A NEW or used generator to replace this unit. If the present unit is series wound, any system of wiring parallel circuits in series to raise the voltage to 240 will subject the insulation to 1.65 times the voltage for which it is designed. Rather than rewinding, trade in the present generator for one with a suitable rating for the purpose.

HOWARD HOLCOMBE
Los Alamos, N. M.

DOUBLE PRESENT VOLTAGE by regrouping the armature coils in this generator into a 2-circuit series winding. Field must be completely rewound, matching present copper weight with one half the existing cross-sectional area.

If *JS* uses two sizes of wire in rewinding the field coils, he should keep the smaller wire on the outside to secure better heat radiation.

L W FITZPATRICK
Jefferson City, Mo.



WITH FIXED SPEED of the armature, generator voltage can be increased by changing the flux density of the poles. To increase flux density we must change the exciting current through either the series or shunt winding, or both. Terminal voltage of field circuit or the field resistance is changed to vary the exciting current.

Changing the reluctance of the magnetic circuit while keeping the exciting current constant will vary the flux. Either the armature can be moved axially out from the poles, or a portion of the field core can be moved radially, as in the sketches.

A third method of changing voltage depends on the magnetic effect of the armature current. It is seldom applied, however.

The most commonly used method of changing generator voltage is by varying the exciting current through either the series or shunt winding, or both. If the field coils are now in series, change in field resistance may be obtained by cutting out one or more series coils, or by using a field coil having a fewer number of turns.

H B WAYNE *Brooklyn, N. Y.*

A LAP-WOUND GENERATOR is easier to reconnect than a wave-wound unit. For the lap winding the number of paths through the armature is equal to the

(*Continued on page 228*)

YOUR MAY PROBLEMS

1 How can we set up our plant jobs?

I have the task of setting up an organization chart for a medium-size manufacturing plant we plan to start soon. To be sure I'm on the right track I'd like some help.

The new plant will have a large number of motor-driven production machines requiring both mechanical and electrical maintenance. It will also have modern elevators, conveyors, lighting, fire-protection and safety systems.

Three boilers will supply steam for process, heating, air conditioning and other services. We will have many pumps and air compressors for production. We will also have usual auxiliaries.

How are the power-plant and plant-engineering jobs best set up so they will be easily directed and controlled? How is responsibility for design, operation and maintenance divided? Who reports to the man in charge? What are the usual titles?

I believe my questions could best be answered by organization charts tracing the flow of authority from the top man right down to operators and maintenance men in the plant.—*CC*

2 How can we protect pumps?

We have three 100-gpm centrifugal pumps for handling oil in our metal-working shop. Oil is supplied to the various machines for cooling of parts that are being worked in production.

These pumps were installed three months ago and have been a constant source of trouble. Wear in the casing, impeller, seals and wearing rings is excessive. We believe it is caused by metal chips passing through the pump suction strainers. Also, we think the oil may carry corrosive substances to the pumps.

How can we reduce this wear? Can the oil be treated in a sump before it reaches the pumps? What are good piping hookups for recirculated oil? —*MV*

Will you help readers who sent problems? Extra pay for photos, sketches.

EXTRA MARGIN OF SAFETY... The tremendous sealing power of the Flexitallic Spiral-Wound Gasket is sometimes taken for granted in this age of jet propulsion and atomic energy. Yet, it is the extra margin of safety built into each Flexitallic Spiral-Wound Gasket that has made possible many of the great developments in aviation, atomic research and development, process industries, power plants, ships of the Navy and merchant marine . . . Each Flexitallic Gasket is engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally wound V-crimped plies of required metal with alternating plies of proper filler results in a resilient gasket having characteristics of a calibrated spring. Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 4000 lbs., from extreme sub-zero to 2000° F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". With Teflon filler for corrosive chemical conditions. Write us your requirements . . . Flexitallic Gasket Company, 8th & Bailey Streets, Camden 2, New Jersey. Representatives in principal cities. Consult classified telephone directory.

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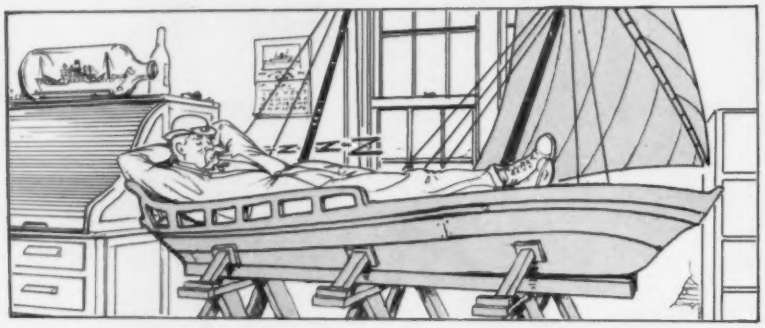
ARGUMENTS

Here's the place to unload your gripes and express your ideas. Shoot in a letter on your favorite subject



Marmy enjoys sleeping on this setee

FIRST, LET ME SAY that the Marmaduke stories are fine. And I surely enjoyed reading the bound collection.

But "The Boiling Coffee Pot," March POWER, has me confused. It says that Marmy put his kangaroo skins on a "setee." This seems rather odd as the name of a kind of Mediterranean fishing boat can be spelled either "setee" or "settee," but just plain "settee" is something you sit on.

I don't think even an old seaman like Marmy would have his office all fumbled up with fishing boats.

G C THORNTON *Englewood, N. J.*

EDITOR'S NOTE: *As an extraordinary consulting engineer, Marmy sleeps on the setee pictured above whenever he feels like it. But when he entertains visitors like Reader Thornton he may have them sit on a more conventional leather settee. Now is it clear?*

Enough vacuum drop could make safety valves pop

AS AN ENGINEERING PROPOSITION the idea presented by Turner (March "Arguments") could lead to confusion. Any engineer with turbine experience knows that considerable increase in backpressure calls for more steam to carry the same load. Instead of blowing safeties you blow a gasket, but evidently there is a difference in these two conditions.

It's true that the weight of steam flowing through a nozzle does not change while throat pressure stays at less than 0.58 of initial pressure. But when it goes higher this rule no longer applies.

Marmy's tablecloth drawing shows this feature clearly; flow begins to taper off at the 50-lb line and nose-dives to zero at 100 lb. As backpressure increases, flow through the throat decreases. According to the formula,

$$V_t = 224 \sqrt{H_i - H_t}$$

where V_t is velocity at throat section, fps, H_i is heat content at the absolute initial pressure and quality of the steam, Btu per lb, H_t is heat content at the absolute throat pressure and the quality at the pressure resulting from a constant entropy change.

(*Continued on page* 254)

Try out your theory on safety popping

I WAS ASTOUNDED at the steam-flow comments in March POWER, p 138. Haven't you had any experience in the days when a man had to get along without automatic equipment?

I'll admit that a turbine is a nozzle, or a whole series of nozzles, but that does not solve the problem of the dropping vacuum. When you lose vacuum the safety valves pop, as anyone knows.

As an experiment, take your staff to some out-of-the-way plant. While the boys are engaging the guide, you slip around and turn off the steam to the ejectors for a moment. Then, quick like a bunny, run out and see what happens to the boiler-room foreman. And take along a wire recorder to hand this down to posterity.

Let me know what you find out. I can't wait to hear.

AL GROTE *Ocean Park, Calif.*

EDITOR'S NOTE: *On the way to try out Reader Grote's suggestion we stopped to consult Marmaduke. He roared:* "BILGEWATER ON POPPING SAFETY VALVES! *I'd like to see Grote pop one with only a 5-inch drop in vacuum, when his turbine valves are wide open!*"

Engineers are forgotten men in our hospitals

I READ YOUR EDITORIAL, "Hospital Plants Need a Doctor," March POWER, with a great deal of interest. I have been one of those forgotten men for 24 long years. Everything that possibly could happen has happened to me.

Right now, I am lucky enough to have a manager who lets the engineering department strictly alone. When I need fuel oil, packing, lamps, or other supplies I order them, and frequently have been able to institute economies.

But I struggled for years with a manager who forced me to use a knock-down and drag-out technique to get any supplies whatsoever. Needed repairs would go unreported up to the point of total failure because hospital personnel were actually afraid to report them. The manager would resent and deplore the purchase of a single box of fuse plugs. Ordering a carload of coal was an ordeal I hate to think about, even after a lapse of 20 years.

To my mind, the chief engineer of a small hospital has one of the most responsible and nerve-racking positions any where, any time. He is responsible for everything from the elevator controls to the potatoes.

He may be called to give emergency engineering advice during an operation. The nurse or anesthetist may need his assistance. He must care for kitchen equipment like dishwashers, slicers, gas stoves, electrically heated food wagons. He services and repairs all laundry equipment like mangles, dryers, extractors, presses, motors and belts. The boiler room, X-ray department, trucks, and station wagons need his services.

This is only part of it. Just routine.

The really staggering thought is that there may come a cold winter night when the boiler in operation may conk out and all the chief's know-how will not get it "on the line" again.

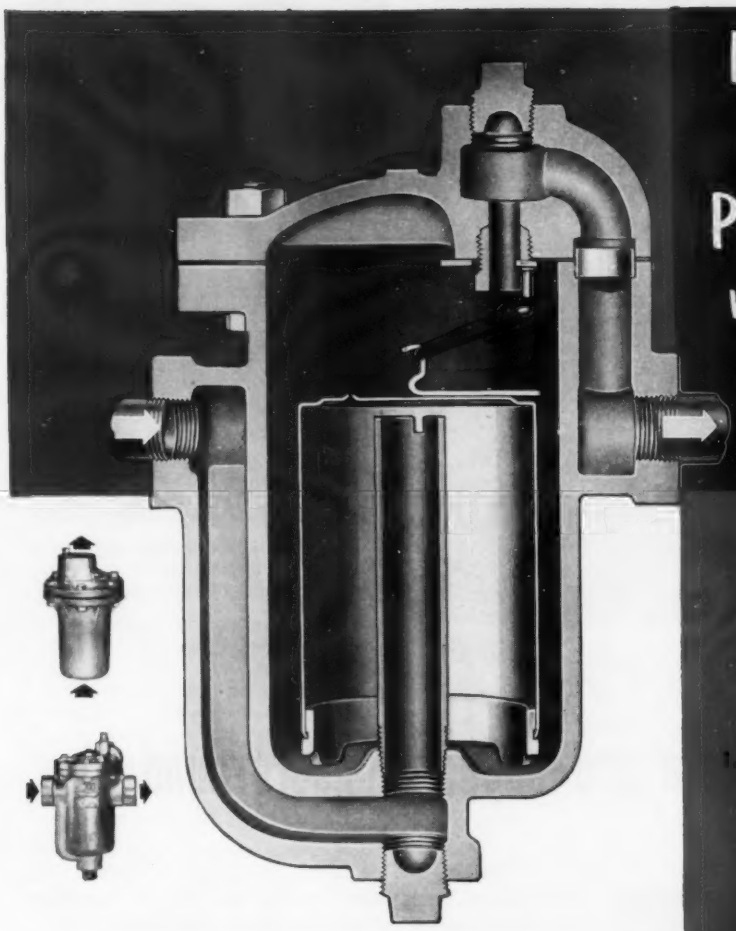
A H PARKER *Peterborough, N. H.*

Are solvents harmful?

I HAVE BEEN TOLD that some solvent cleaning materials are harmful to precision-type ball bearings. For instance, I am informed that carbon tetrachloride definitely attacks such bearings, and that xylene also has an effect.

Has any reader more information on the matter? I understand that many engineers use carbon tetrachloride to clean motor windings and ball bearings.

NELSON FULLER *Batavia. N. Y.*



MORE TRAP CAPACITY PER DOLLAR with Armstrong two-phase leverage

Two-phase steam trap leverage is an original development by Armstrong and has been incorporated in Armstrong traps since the memory of most engineers runneth not to the contrary. It provides:

1. High initial leverage to open the valve against pressure.
2. Secondary lower leverage which permits the valve to travel well clear of the seat to minimize restriction to flow of condensate.

A single-phase lever can open just as large a valve *or* give just as great valve travel, *but not both.* Thus, Armstrong two-phase leverage gives very much greater capacity, depending on trap size than the earlier leverage system.

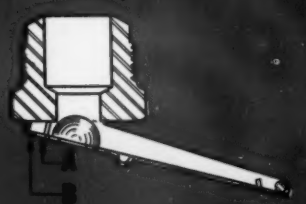
No steam trap gives greater actual hot condensate capacity, size for size, and dollar for dollar, than an Armstrong!

For complete data call your local Armstrong Representative or send for the 44-page Steam Trap Book.

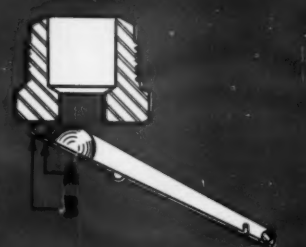
ARMSTRONG MACHINE WORKS
812 Maple Street, Three Rivers, Michigan

HOW IT WORKS:

1. Valve in closed position.



2. As the bucket starts to sink, the lever fulcrums at "A", giving high leverage to open the valve against pressure. When valve is well open, the secondary fulcrum "B" touches the face of the valve seat.



3. Additional bucket travel results in fulcrum "B" becoming the pivot, permitting the valve to be opened wider so that restriction to flow of condensate is minimized.

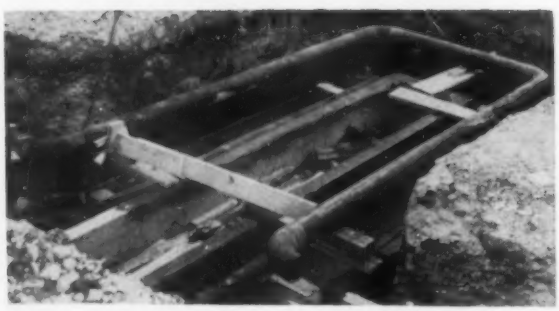
ARMSTRONG STEAM TRAPS

1 Insulating blocks resting on concrete foundation support this 2-pipe system. Pipes are anchored to concrete base

2 Over-and-under double-pipe system has inverted U-shape support blocks for top tube. Blocks are on 10-ft centers

3 Wrap pipe in corrugated paper, pour insulating concrete into wood forms, and tamp lightly to insure complete fill

HOW TO Insulate and support underground pipe



4 At expansion bend, use special mix poured into structural concrete chamber. Expanding pipe makes void in special mix

► FIREPROOF INSULATING CONCRETE serves as a complete covering system for underground piping. The efficient, lightweight, stable material supports pipes as well as insulating them; no rollers, rods or hangers are used.

Installed by authorized representatives of the manufacturer, the insulating material is noncorrosive, water-resisting, rotproof and verminproof.

You can install any number of pipes, of any size, in the conduit, using a concrete base with a minimum thickness of 3-in. When it would be undesirable to use a structural-concrete casing and special insulating mix for expansion loops, as pictured, glass wool may be wrapped around the pipes at the loops. —*Courtesy Zonolite Company*

5 Forming corners at T intersections: For heavy traffic conditions, put structural-concrete casing around insulation

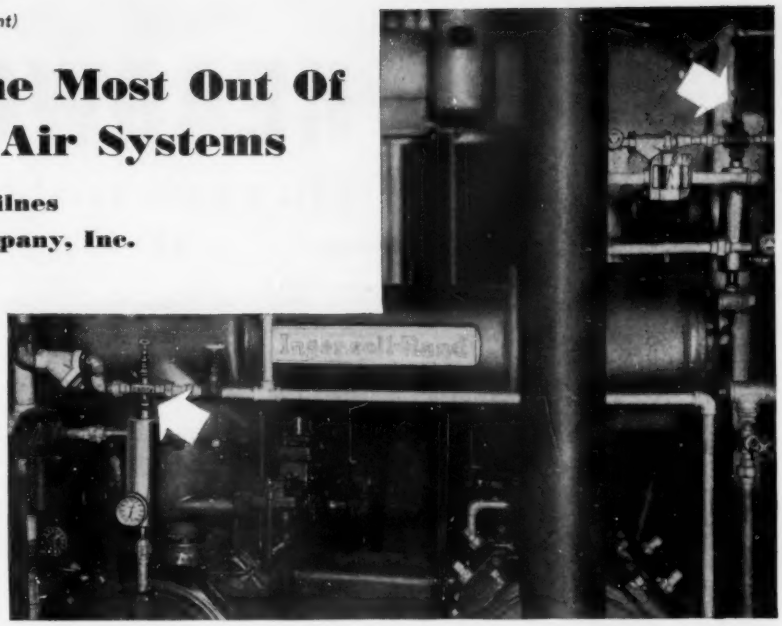
6 Finish off conduit with an outside waterproofing membrane to aid curing of insulating concrete and to keep water out

(Advertisement)

How To Get The Most Out Of Compressed Air Systems

A. Milnes

Sarco Company, Inc.



The replacement of hand controls by Sarco automatic cooling controls on this 2-stage Ingersoll-Rand compressor resulted in better lubrication, less condensate in air, and a considerable saving in cooling water.

THE practical place to measure the capacity of your compressed air system is where it counts the most—at your compressed air tools. From the time air is first drawn into the cylinder, many things can happen which will effectively reduce air pressure and limit compressor capacity. Following is a concise explanation of the major causes of reduced compressor capacity and the steps which can be taken to remedy them.

PROPER AIR INTAKE

Your compressor system can be fouled up before a pound of air has been compressed if the air intake has been improperly located. The air intake should be located where the atmosphere is clean, cool, free from corrosive chemical fumes, and dry to minimize condensation in the system.

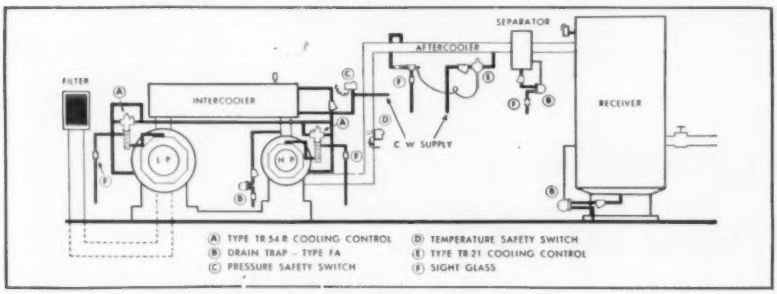
INTAKE PIPE DESIGN

A compressor can only operate at rated capacity if its air supply is unimpeded. Twisting, undersized pipes and dirty filters can effectively reduce air pressure at the compressor inlet. For example, a pressure loss of 2 psi due to friction in the intake pipe and filter will reduce the output of a 125 psi compressor by 7.5%. Check intake pipes and make sure they are short, of adequate size, and free of sharp bends.

AUTOMATIC COOLING CONTROL

One of the major causes of inefficient compressed air operation is unbalanced cooling. For example, overcooling wastes water, causes deterioration of compressor lubricant by condensation in cylinder head. On the other hand, undercooling reduces compressor capacity, may result in serious damage to cylinders, pistons, valves and seats.

To offset this, many compressor manufacturers such as Schramm, Ingersoll-Rand, and others install Sarco automatic cooling controls at the factory. These controls are self-modulating, insure optimum cooling effect with minimum water consumption regardless of load variation, changes in pressure and temperature of water supply.

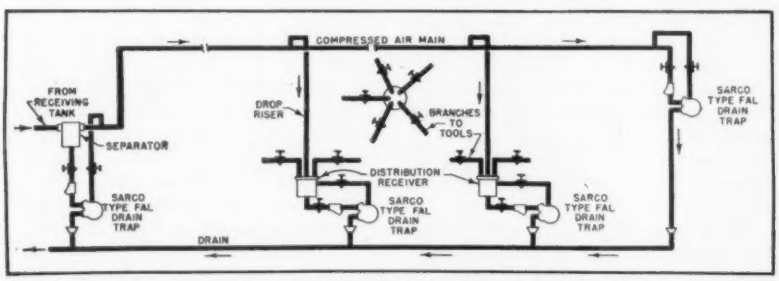


Sarco cooling controls are installed to regulate the water supply to cylinder jackets so that jacket discharge temperature is between 100-115° F.

CONDENSATE REMOVAL

If condensation is not kept to a minimum serious damage can result to tools, paint surfaces, molds, etc. Other results of excessive condensation in the system are water hammer and freezing of mains, receivers and tool exhausts.

To prevent this, well-designed compressed air systems usually have Sarco drain traps installed at the aftercooler, on separaters, at receivers, and on low points in the lines to remove water as quickly as it collects.



Drain traps at critical points in the distribution system effectively remove condensate—protect compressor equipment, tools, and work.

FREE TECHNICAL ADVICE

Sarco engineers have prepared a technical bulletin designed to pass on to compressed air users practical advice on how to improve air compressor operation. It also contains simple hook-ups of Sarco cooling controls and drain traps.

This bulletin may be obtained without obligation by writing the Sarco Company, Inc., Empire State Building, N.Y. 1, N.Y. Also represented in principal cities.

HEADWORK

PHIL SWAIN BRINGS ENGINEERING THEORY DOWN TO EARTH

I: Burning carbon with pure oxygen

	C	+ 2O	= CO_2
Parts by weight	12	+ 32	= 44
Pounds	1	+ 32/12	= 44/12
Pounds	1.00	+ 2.66	= 3.66

II: More nitrogen than oxygen in air

	Oxygen	Nitrogen	Air
Parts by weight	23	+ 77	= 100
Lb per lb O	1.00	+ 3.35	= 4.35
Lb per 2.66 lb O	2.66	+ 8.91	= 11.57

III. Weight of oxygen, nitrogen, air, flue gas for one pound of carbon

	Supply				Products			
	Carbon	Oxygen	Nitrogen	Air	CO_2	Oxygen	Nitrogen	Flue Gas
CASE 1:								
No excess air	1.00	2.66	8.91	11.57	3.66	0	8.91	12.57
CASE 2:								
Theoretical air	1.00	2.66	8.91	11.57	3.66	0	8.91	12.57
100% excess air	0	2.66	8.91	11.57	0	2.66	8.91	11.57
Total	1.00	5.32	17.82	23.14	3.66	2.66	17.82	24.14
CASE 3:								
Theoretical air	1.00	2.66	8.91	11.57	3.66	0	8.91	12.57
50% excess air	0	1.33	4.45	5.78	0	1.33	4.45	5.78
Total	1.00	3.99	13.36	17.35	3.66	1.33	13.36	18.35

Combustion Facts-3: *Carbon Burned in Air*

► INDUSTRY'S most important combustible material is carbon, which furnishes most of the heat we get from coal and oil. Hydrogen comes second in importance. Sulfur, a bad third, is of interest not for its heat but as an acid-forming nuisance. This month we talk about carbon only.

Table I, repeated from last month, reminds us that one atom of carbon (weighing 12 atomic units) burns with 2 atoms of oxygen (each weighing 16, a total of 32) to give one molecule of carbon dioxide weighing 44. To put it another way, 12 parts by weight of carbon combine with 32 parts of oxygen to give 44 parts of carbon dioxide. Dividing through by 12 we see that one lb of carbon burns with 2.66 lb of oxygen to produce 3.66 lb of carbon dioxide.

Except in gas welding and a few such specialized operations, pure oxygen is not used in industry as a supporter of combustion. The normal oxygen supply comes to boiler furnaces in the atmospheric air.

By weight, air is 23% oxygen and 77% hydrogen, so every pound of oxygen carries a dead weight of 3.35 lb of nitrogen. This "free riding" nitrogen takes no chemical part in the combustion, but does have practical importance because all the nitrogen fed to the furnace finally goes up the stack at a fairly high temperature. This wastes heat.

On the other hand, some nitrogen dilution is needed to keep the furnace from burning up. Ordinary furnace construction could not withstand the terrific heat of carbon burning in concentrated oxygen.

The least amount of air that can consume one pound of carbon is the amount that contains the 2.66 lb of oxygen required by Table I. Table II shows that 4.35 lb of air contain one lb of oxygen and 3.35 lb of nitrogen. If we multiply all these figures by 2.66, we see that it is impossible to burn one lb of carbon with less than 11.57 lb of air. This air contains 8.91 lb of nitrogen.

EFFECT OF EXCESS AIR

It's good practice to follow all the elements through the combustion process for the three cases shown in Table III: No excess air, 100% excess air and 50% excess air.

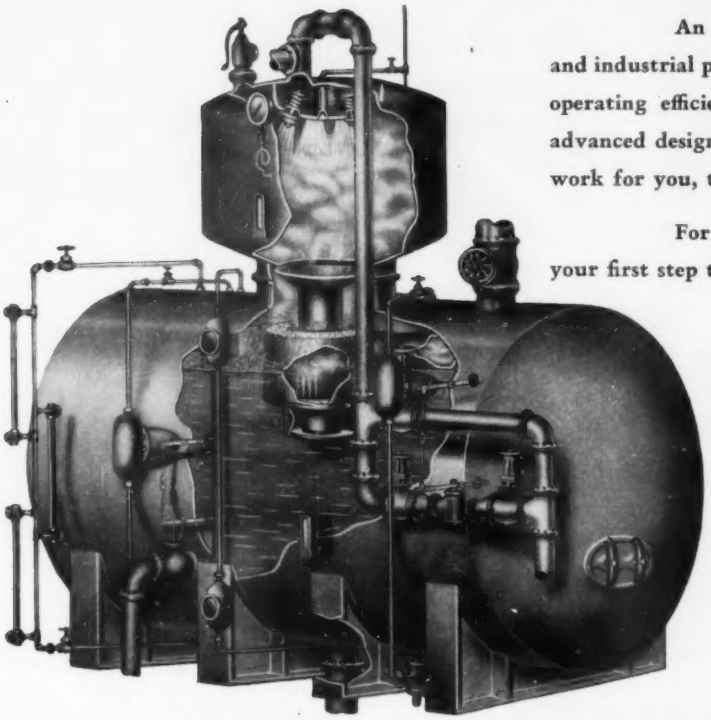
In Case 1, with no excess air, 8.91 lb of dead nitrogen goes through the furnace without being changed in any way. The 3.66 lb of CO_2 produced is diluted with this 8.91 lb of nitrogen to give a total of 12.57 lb of flue gas. In Case 2, for 100% excess air, the extra air is listed on a separate line to show up more clearly. The first line is the same as before. All the second line goes through unchanged. The totals show that the flue gas now contains 2.66 lb of unburned oxygen and that this carries along with it an additional burden of 8.91 lb of nitrogen.

In Case 2, the total weight of flue gas jumps from 12.57 lb to 24.14, which almost doubles the loss from the discharge of hot gas up the stack. This loss is reduced in Case 3 by cutting back the excess air to 50%. Cutting it down to 15% would save still more heat.

In all cases note that the total weight of flue gas is exactly one lb greater than the weight of air supplied. This must be so because all the carbon and air fed to the furnaces goes up the stack.

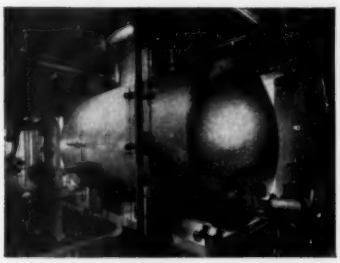
In Deaeration, too

BELCO Builds a Complete Line-



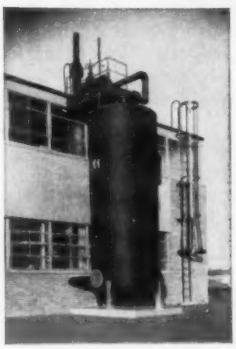
An increasing number of well known utility and industrial plants are using Belco equipment to increase operating efficiency and decrease operating costs. Belco advanced design and application experience can be put to work for you, too.

For technical assistance write or call Belco — your first step to lower costs.



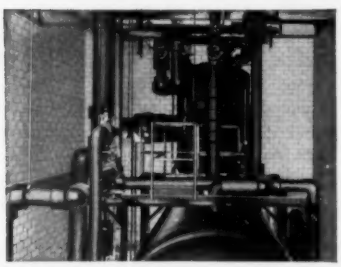
SPRAY TYPE — Belco Deaerator in large eastern oil refinery. Has a capacity of 300,000 lbs/hr.

MARINE TYPE—Typical Belco marine heater furnished to shipyards. (Approved by Lloyds of London)

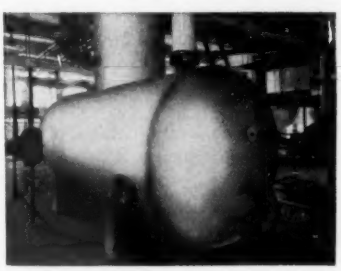


OPEN TYPE—Deaerator at large eastern pharmaceutical plant. Capacity of 80,000 lbs/hr.

VACUUM TYPE — Unit shipped set-up to midwestern utility. Has 150,000 lbs/hr capacity.



SPRAY TRAY TYPE — Belco Deaerator at New York State institution boiler house. Capacity 120,000 lbs/hr.



TRAY TYPE — Belco Deaerator at southern municipality. Has a capacity of 125,000 lbs/hr.

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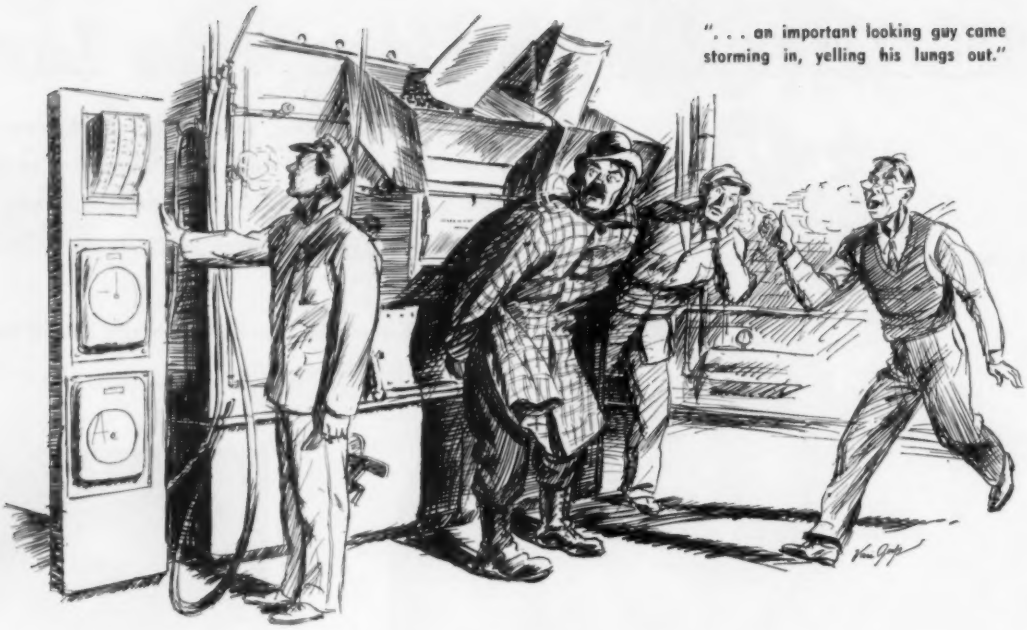


". . . an important looking guy came storming in, yelling his lungs out."

Marmy does a little thawing

► "BILGEWATER ON AUTOMATIC boiler controls run by shovel and slice-bar operators!" I heard Marmaduke Surfaceblow roaring as I climbed the rickety old stairs leading up to his office above O'Houlihan's Machine Shop & Engine Works. "I've straightened out your plant for the last time unless you put a chief in charge who'll use his head instead of his muscles."

This second blast came ripping through the open door after a well-dressed, but very red-faced, man who came hurrying down the steps past me. As I entered the office, I could see that the old consulting engineer had up a full head of steam. There was another man in the room and Marmy introduced him as Leonard Polikoff, one of his old shipmates from Brooklyn.

"Len and I were goin' over some of our old experiences," Marmy explained, "when that paper-jack owner came in here to gripe about the mess his plant's in."

I glanced at Len and saw that he was prepared for the inevitable barrage, so I sat down on the old leather settee and waited for Marmy to ballast his tanks in preparation for sounding off. But the cantankerous old sea dog ignored both of us as he anchored his ancient 6-foot 4-inch hull into his swivel chair.

He reached over and poured himself what looked and smelled like a low-grade drain cleaner from the battered coffeepot sitting on the pot-bellied stove. Then, after working up some induced draft on his cigar butt, he suddenly cut loose with another blast.

"What's wrong with operators today?" he roared, looking at both Len and me as though we'd had something to do with it. "When I started out in '88, you weren't an engineer until you'd knocked around in all kinds of plants. That's why I've operated everything from a steam threshing machine to a Mississippi riverboat.

"But nowadays when a plant is modernized, it takes a crew of consulting engineers to put it in operation. Then another crew to keep it running. WHY? I'll tell you why!" he bellowed, banging his tired old desk with a haymaker and turning red around the gills. "It's because the old help haven't taken the trouble to poke their bows inside other plants—that's why!"

The old boy quieted down to a 140-decibel roar and blasted on. "Back in '27 I made a trip up north by side-door pullman. First I stopped off at my home town in Mildew, Missouri, but that place was so dead that I hit the road for Canada, working in plants along the way.

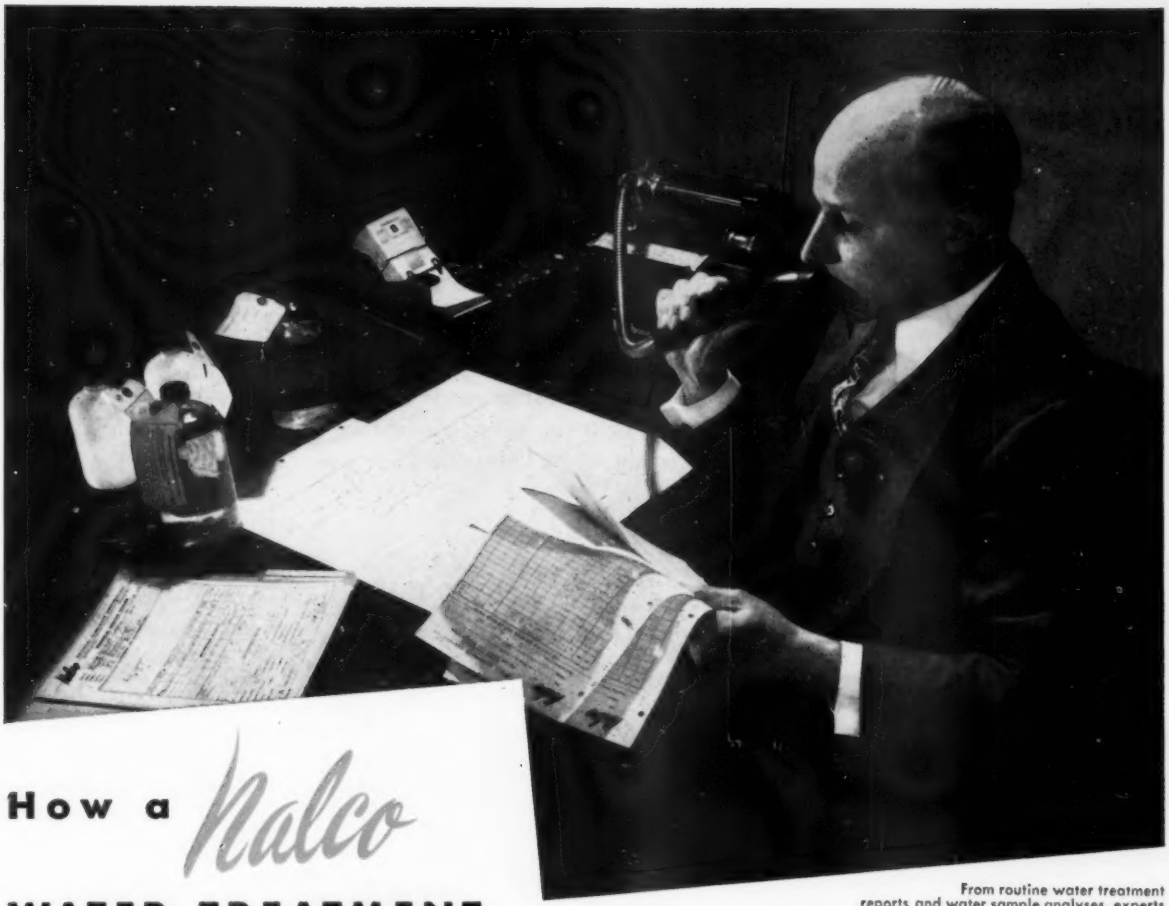
"One morning as we were pulling into Red Bear in northern Minnesota, the temperature hit 30 below. I crawled out of that sheep car and started looking around for a place to thaw out—but fast. There was a big paper mill down the tracks, so I set my frost-covered sights on her stack as I navigated against the gale.

"By the time I hove into the boiler room, I was stiff with cold and close to foundering. After I'd anchored my stern to a boiler and started soaking up some Btu's, I noticed half a dozen operators running around and yelling like mad. Then it dawned on me that the boilers' safeties were popping.

"Soon as the heat from that boiler had thawed my cargo boom a little, I reached into my overcoat pocket and stoked my own boiler from my bottle of Sandpaper Gin. That fuel was the only thing that had kept me from freezing to death in that rattler night before. By now the icycles were melting off my whiskers, so I started taking some interest in the 3-ring circus going on around me.

"Only thing I could figure was that the operators were trying to get those boilers off manual and onto automatic control. From where I stood, the gages seemed to read OK. Everyone was excited and they were monkeying with

(*Continued on page* 242)



From routine water treatment reports and water sample analyses, experts at Nalco Laboratories keep a complete record of your plant water treatment — can assist materially in maintaining permanent water treatment security.

How a *Nalco* WATER TREATMENT SERVICE AGREEMENT WORKS FOR YOU

OPERATION of your plant under a Nalco Water Treatment Service Agreement gives you two important safeguards against water treating problems in any form. First, Nalco will provide proper water treatment chemicals and procedures. Second, an experienced Nalco Service Representative will make regular visits to your plant, and is on call at any time to deal promptly with emergencies. Whether you have 10 or 10,000 BHP, this combination will provide what thousands of Nalco System users have learned to take for granted: *permanent water treatment security.*

Write, now, for full information on a Nalco Service Agreement for your plant.

Nalco

SERVICE AGREEMENT SECURITY FEATURES

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- **LABORATORY ANALYSES** of water samples . . . Initial complete analyses, followed by routine sampling and analyses as checks on plant tests.
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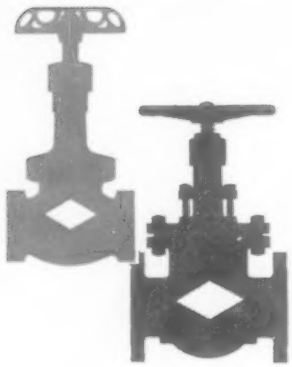
Buyers' Guide to lasting valve economy



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Buffalo	H. R. Kelly Company, Inc. McElroevy & Hauck Co. Saltser & Weinsier, Inc. The Smyth-Donegan Company John Wilfert Company W. A. Case & Son Mfg., Co. Stritt & Priebe, Inc.
Elmira	Irving D. Booth, Inc. LeValley McLeod, Inc.
Ithaca	Haverstick & Co.
Jamestown	Clark Hardware Co.
Kingston	W. A. Case & Son Mfg. Co.
Long Island City	Bess Supply Company, Inc. Conran Supply Co., Inc. Gar Supply Corp. Mayer-Malbin Company, Inc.
Massena	Hyde Plumbing Supply Corp.
Middletown	Orange County Plumbing Supply Co.
Mineola	Behrer-Nason Company, Inc.
Newburgh	W. A. Case & Son Mfg. Co. W. L. Smith Co.
New York	Behrer-Nason Company Davis & Warshow, Inc. Glauber, Inc. Charles F. Guyon, Inc. W. H. Hussey & Son, Inc. Herbert Reck Supply Corporation Smolka Co., Inc.
Niagara Falls	W. A. Case & Son Mfg. Company Elderfield Hartshorn Hardware Co.
Ogdensburg	Utica Plumbing Supply Co., Inc.
Olean	LeValley McLeod, Inc.
Oswego	M. B. Crawford & Son
Port Chester	Central Plumbers Supply Co., Inc.
Poughkeepsie	Interstate Plumbing Supply Co., Inc. J. D. Johnson Co., Inc.

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White Plains	Behrer-Nason Company, Inc.
Woodside	Neill Supply Co., Inc.
Yonkers	Glauber, Inc. Joseph C. Ryan & Sons, Inc.

NORTH CAROLINA

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Charlotte	Grinnell Corp. Hajoca Corporation Textile Mill Supply Co. The Henry Walke Company
Durham	Dillon Supply Co. Noland Company, Inc.
Fayetteville	Piedmont Supply Co., Inc. Standard Supply Co., Inc.
Gastonia	Gastonia Mill Supply Co.
Goldsboro	Dillon Supply Co.
Greensboro	Frank Hackett Supply Co. Odell Mill Supply Co. Piping & Equipment Supply Corp.
Hickory	Piedmont Supply Co., Inc.
High Point	Kester Machinery Co.
Raleigh	Dillon Supply Co. Noland Company, Inc.
Rocky Mount	Dillon Supply Co.
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Dayton	The Acme Plumbing Supply Co.
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Mansfield	Conte Plumbing & Heating Sup., Inc.
Steubenville	Industrial Supplies Co.
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Woonsocket	Woonsocket Supply Co.

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Charleston	Charleston Supply Co.
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Spokane	Northwest States Supply Co. Sullivan Valve & Engineering Co.
Tacoma	Paramount Supply Co.
Walla Walla	Drumheller Co.

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Weston	Danser Hardware & Supply Co.
Wheeling	Trimble & Lutz Supply Co.

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Green Bay	Murphy Supply Co.
Kenosha	P. H & I Supply Co.
LaCrosse	W. A. Roosevelt Co.
Madison	Rundle Spence Mfg. Co.
Manitowoc	William Rathsack & Sons Co.
Milwaukee	F. R. Dengel Co. B. Hoffmann Mfg. Co., Div. Grinnell Corp. Rundle Spence Mfg. Co.
Nekoosa	Nekoosa Fdry. & Mchne. Works, Inc.
Oshkosh	Battis Bros.
Racine	Thomas Supply Co.
Sheboygan	Optenberg Iron Works
Watertown	Kusel Dairy Equipment Co.

Speaking of power

personal slants on doings of interest to power men—some significant, some just odd

Trend to modernization is growing stronger—McGraw-Hill's Survey of Business' Plans for New Plants and Equipment shows 57% of capital spending in 1954 will go to modernization, against 43% for expansion. Last year's figures were 52% for revamping, 48% for plant additions. Big push behind modernization is need to cut costs in what shapes up as a period of intense competition.

Survey shows total industry capital expenditures in 1954 will be only 4% less than in 1953, while manufacturing industries will spend about the same. Automotive, food, machinery and electrical industries lead the parade—they'll spend more in '54 than in '53.

Energy needs in 2050 AD will be more than 20 times present world-wide use, says Palmer Putnam in a new book, Energy in the Future. Studies made by Putnam for the Atomic Energy Commission indicate world population may grow from 2.4 to 6 or 7 billion and the next 100 years may see more energy consumed than in all past history. Where's it all to come from?

Today, most energy comes from fossil fuels—77%. Remaining 23% comes from continuous or "income" sources—water and wind power, solar energy, vegetable fuels. Putnam's estimates credit these present energy sources with meeting only 40% of needs in 2050—the rest must come, he says, from the atom.

Not enough time to read? Most of us can't do much about finding more time, but we can learn to do more reading in the same time. Today's teaching methods can increase reading speed even for those of us who learned the ABC's many years ago. Take a look around to see if such training isn't available to you.

Nuclear-reactor catalog —first of its kind—has been issued by North American Aviation. It describes and illustrates three basic types of small reactors: (1) a solution-type ("water boiler") unit rated at 50 kw, (2) a pool-type design in the 100 to 1000 kw class, and (3) a homogeneous graphite reactor of 160 kw.

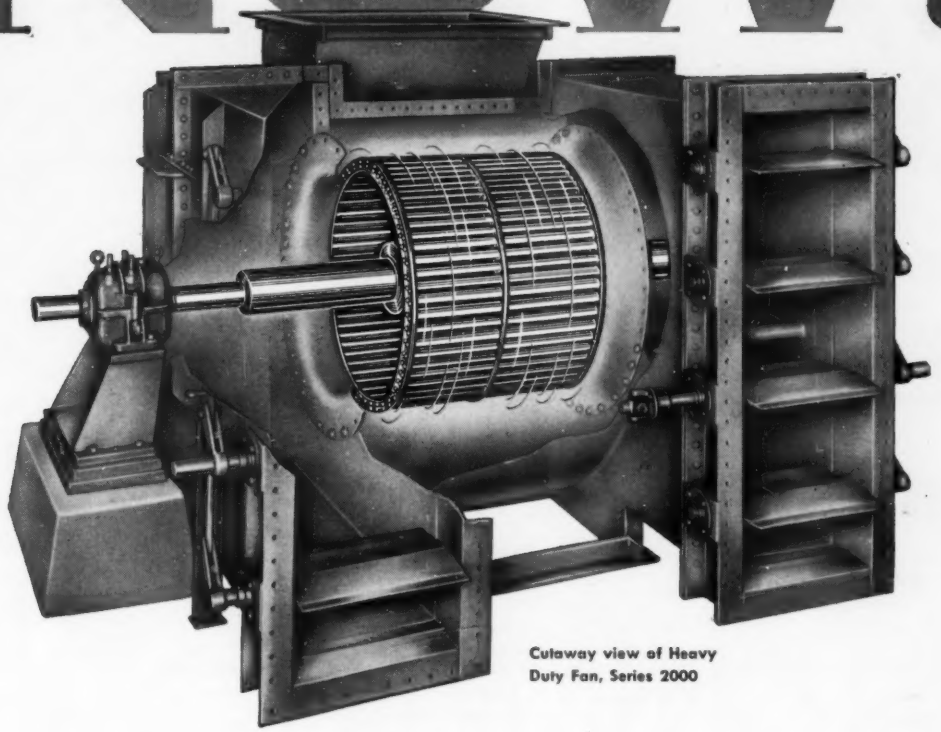
Ratings in kw are for convenience only; these are research reactors and not designed for power production. Suggested applications: as a low-cost neutron source for general research, as a source of neutron beams for medical or biological use, for preparation of radioactive chemicals or short-lived isotopes, as training and research facilities in schools of nuclear engineering.

More news on the atomic front shows the evergrowing commercial interest in nuclear energy. Announcing an agreement with AEC to study equipment aspects, C H Gay of Babcock & Wilcox Co said, "B&W is looking forward to the time when it can assume a position as an equipment supplier in the nuclear power business similar to the position it now holds in the conventional power business."

Among items to be considered in a study agreement between AEC and Bendix Aviation Corp is design of mobile reactors for power supply in disaster areas. M P Ferguson, Bendix president, believes "...It may be practical to design atomic power plants small enough to set on railroad cars..." such reactors might also prove attractive for remote mining operations, military bases, etc.

Lou Lowley

NOW!



Cutaway view of Heavy Duty Fan, Series 2000

a **more efficient** heavy duty fan with Forwardly Curved blading

Here is the *NEW* Heavy Duty Fan, with forwardly curved blading, designed specifically for induced draft service. This Series 2000 fan has wide application in steam plants of public utilities and industrial plants for both process steam and power generation. Sturtevant Division has long recognized and manufactured fans with forwardly curved blading . . . and as a result, designed into *this* fan the maximum air handling capacity and efficiency yet obtained in forwardly curved blading.

By comparison this Series 2000 Heavy Duty Fan has:

(a) lower first cost—smaller space requirement
(b) greater air output for less power input
(c) more efficient conversion of velocity energy

Air Handling power specialists located strategically across the country possess the know-how and engineering information to assist you in selecting this Series 2000 fan to your specific requirement. Contact your nearest Westinghouse-Sturtevant Office, or write to Westinghouse Electric Corporation, Sturtevant Div., Hyde Park, Boston 36, Mass.

Now just off the press is a new catalog describing the Heavy Duty Fan, Series 2000, in detail.

Fill in the attached coupon and send for your copy of Catalog 1380 today.

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Please send me your copy of Catalog 1380 describing in detail the new Heavy Duty Fan, Series 2000, with forwardly curved blading.

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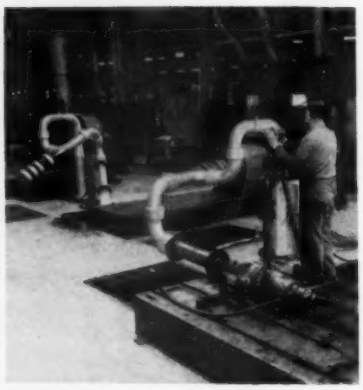
THIS LABORATORY can duplicate field conditions for 10,000 different pumps



SPECIAL PIPING simplifies pump hookups

Worthington opens giant test lab

► WORTHINGTON CORP recently opened one of the largest, most complete and flexible hydraulic test laboratories in the world. The new installation, located at the company's Harrison Works, covers more than 20,000 sq ft, has been three years in the planning and building.

Designed basically for production or performance testing, the huge "hydraulic proving ground" will also be a valuable tool for applied research and development of fluid-handling machinery. Here, engineers will be able to confirm their theoretical calculations by actual observation of the full performance characteristics of pumps.

This laboratory can duplicate hydraulic field conditions for more than 10,000 different types and sizes of pumps. Range can be from fractional hp to capacities above 100,000 gpm. Since many of the pumps manufactured at Harrison are engineered individually for top performance and for specific operating conditions, former testing often required special test setups for each unit.

Important features of the laboratory are its accommodations for testing large centrifugal refrigeration equipment. Here, it is possible to test the giant centrifugal machines used to deliver air-conditioning to huge buildings such as the new Alcoa building in Pittsburgh.

The new installation consists of several areas: standard test setup area, large and special test setup area, high-speed test area and power-pump test area. Banks of under-floor venturi meters and permanently installed instrumentation, controlled from a central room, were designed to handle a wide variety of production pumps. Large parallel under-floor water channels run along each side of the main bay and are connected by cross channels. These, combined with the power and steam facilities, allow testing of pumps with capacities in excess of 100,000 gpm.

AEC plans broad atomic power program

► LEWIS L STRAUSS, chairman of Atomic Energy Commission, has announced that a proposal submitted by participation by Duquesne Light Co in construction and operation of first full-scale central station nuclear power plant is the most favorable to the government and that AEC is negotiating a formal agreement.

Under the Duquesne proposal, one of nine major proposals submitted, the company would:

1. Furnish site for entire project and build and operate new electric generating plant at no cost to the government.

2. Operate reactor part of plant and bear labor costs thus entailed.

3. Assume $5-million of costs of research, development and construction of reactor portion of plant.

4. Pay AEC at rate of 48.3 cents per million Btu's of steam used in turbines for first year, this rate increasing annually until it reaches 60.3 cents in fifth year.

5. Waive any government reimbursement for costs incident to termination of contract.

Strauss estimated that, including revenues from sale of steam generated by the reactor, the company's proposal would reduce by $30-million expenditures the government would have to make during period of construction and five years of operation if it undertook full cost of project.

(*Continued on page* 220)

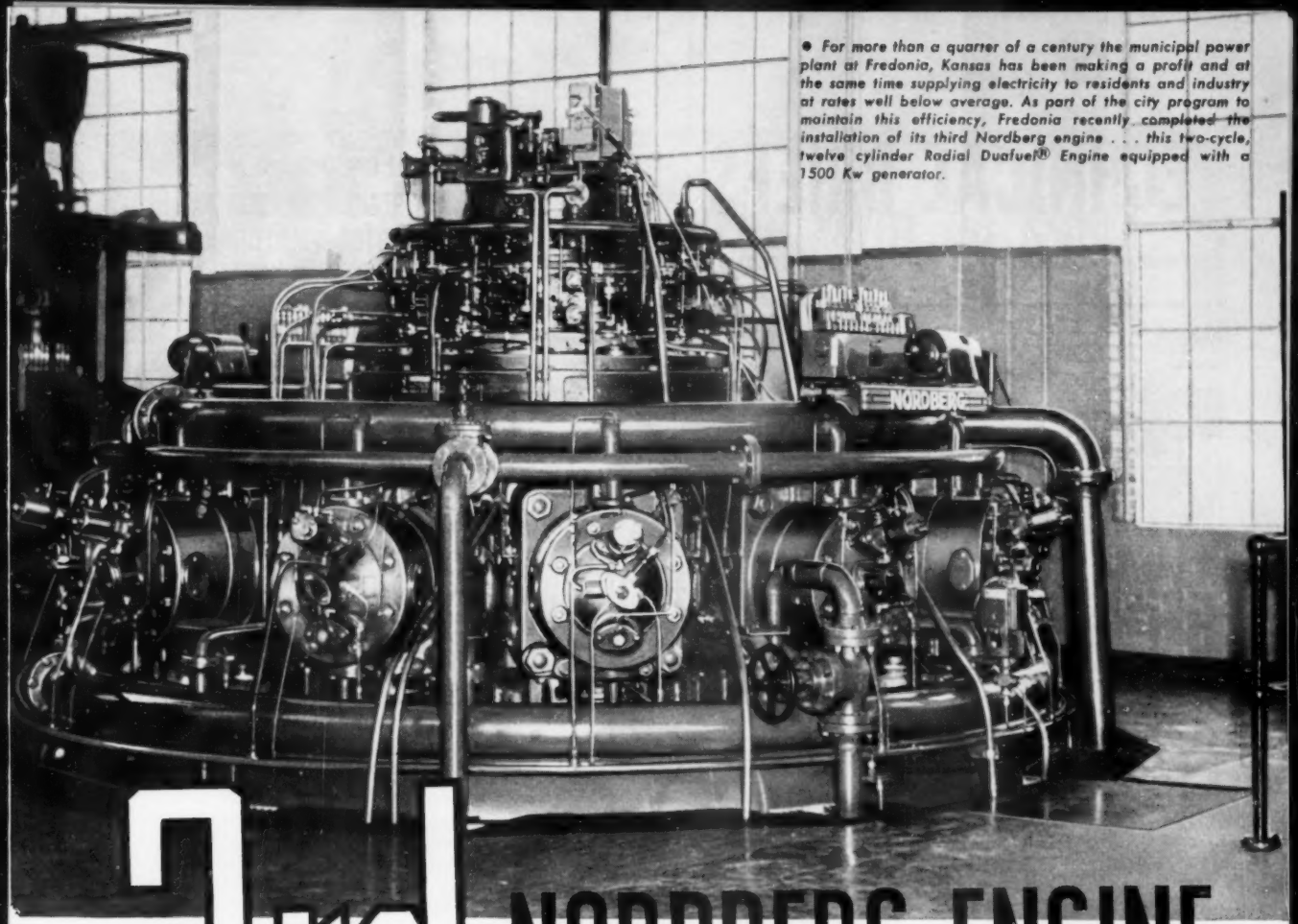
For coming events see page 226

Chrysler uses regenerator in automotive gas turbine

► OPERATING IN A 1954 Plymouth coupe, Chrysler Corp's new automotive gas turbine uses a regenerator to give fuel-economy characteristics equaling those of a conventional auto engine. The regenerator also overcomes the problem of exhaust heat—exhaust of the new unit, the company claims, is cooler than that of an average car.

While Chrysler engineers keep details under wraps, shrewd guesses indicate the regenerator is of the rotary type. This was foreshadowed in the 1952 ASME Gas-Turbine Progress Report, compiled by R Tom Sawyer. In the section by P F Martinuzzi appears this significant comment: ". . . the combination of a low-pressure cycle with single-

(*Continued on page* 222)



• *For more than a quarter of a century the municipal power plant at Fredonia, Kansas has been making a profit and at the same time supplying electricity to residents and industry at rates well below average. As part of the city program to maintain this efficiency, Fredonia recently completed the installation of its third Nordberg engine . . . this two-cycle, twelve cylinder Radial Duafuel® Engine equipped with a 1500 Kw generator.*

3rd NORDBERG ENGINE for Fredonia, Kansas

"BOX SCORE"	
1931	Fredonia installs 600 Kw Nordberg two-cycle in-line Diesel engine.
1948	Second Nordberg engine installed . . . a 900 Kw, six-cylinder four-cycle Duafuel® unit.
1953	Third Nordberg installed . . . a two-cycle twelve-cylinder Radial Duafuel® engine direct-connected to a 1500 Kw generator.

With the successful and economical operation of their first two Nordberg engines, it was natural that Fredonia again turned to Nordberg for an economical solution to their latest power expansion problem. It is interesting to note that the Radial engine was chosen primarily because it could be easily installed in a limited space, without increasing plant size.

Operating very satisfactorily on natural gas and pilot fuel, the Nordberg Radial Duafuel® engine has been on the line since November, 1953. It is instantly convertible to gas or oil fuel at the movement of a single lever.

Looking for dependable, economical main or stand-by power? Then consider Nordberg . . . builders of America's largest heavy duty engine line . . . 10 to over 10,000 hp.
Nordberg Mfg. Co., Milwaukee, Wisconsin.

NORDBERG

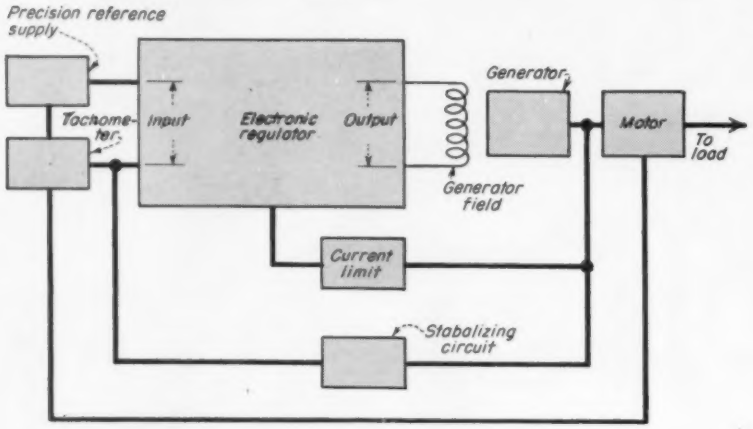
DIESEL • DUAFUEL® AND SPARK-FIRED GAS ENGINES

P354

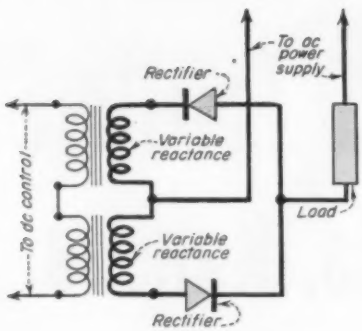
TECHNICAL BRIEFS

Latest engineering developments for busy power men

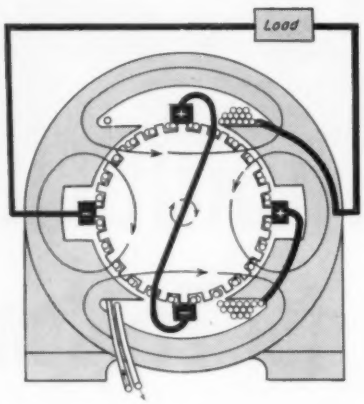
11 Digests for you on:
REGULATING SYSTEMS
MOTOR PROTECTION
MISCELLANEOUS



1 Electronic



2 Magnetic-Amplifier



3 Rotating

Which regulator is best suited?

Industrial Regulating Systems Using Electronic Regulators. *By E J Luoma, Control Engineering Dept, Reliance Electric & Engrg Co, Cleveland, Ohio.*

Low power input of electronic regulators is a big advantage in regulating systems. For all practical purposes, input power in fractions of microwatts may be neglected during regulator application. Along with low power input, power gain of the electronic system is practically infinite: power gain of a typical 1-kw electronic regulator will be at the 4-trillion level. Fig. 1 shows the elements of a typical system.

Since amplifying elements themselves are resistive, the electronic regulator can have practically instantaneous response. This makes system response dependent upon motor or generator field under control and reduces number of time-constants in regulating loop. A simple potentiometer adjustment can make response of the electronic unit vary over a wide range to obtain best results on a particular application. Because of its high gain and flexible stabilizing controls, the electronic regulator is equally well adapted to speed, voltage, tension or position control.

Since component parts—resistors, capacitors, tubes, etc—are small and lightweight, the regulator itself is small and light. This saves space in control assembly and in the user's plant.

Drift and hysteresis, which cause changes in operating points on regulators, are absent from present-day electronic speed regulators. Early electronic regulators gave trouble with drift, but, by compensating networks built into the regulator, maximum drift during first 15 minutes of operation (usually the most critical with respect to drift) can be kept down as low as one part in a thousand. After initial warm-up period, operating-point drift is negligible.

Disadvantage of the electronic system is that the tubes have a definitely limited life expectancy. However, by improved mechanical construction and filament design, the tubes are quoted as having under one-half percent failures during the first 200 hr and over 90% exceeds 10,000 hours of useful life. The majority of failures can be classified as being due to loss of emission which can be predicted by regular tube checks. The proposed Trans-Atlantic telephone cable will have over 300 high vacuum tubes. Results of extremely long-life tube development for such projects will soon become available for industrial use.

Output of the electronic regulator is for a single polarity only. Where both positive and negative polarity output is required, it is common practice to regulate through an auxiliary control exciter or to use a bias field along with the main control field of the regulator.

Early electronic units, because of their mechanical construction, were not overly rugged, but with present trends in regulator design and tube construction, the regulator has completed its transition into the industrial field so that the term rugged can be applied to it.

The day has passed when our industrial processing lines can be without regulators. Five percent accuracy can no longer be considered satisfactory performance. Where accuracy and consistent performance are required to reduce scrap or to increase quality and quantity of product, there is a place for the electronic regulator. *AIEE conference paper available from author.*

Magnetic-Amplifier Regulator. *By R W Moore, manager, control development engineering, Westinghouse Electric Corporation, Buffalo, N. Y.*

Magnetic amplifiers neither replace

Looking for the right packing for your centrifugal pumps?

For shaft speeds to 1750 RPM Johns-Manville Centripac seals better

WEAR on centrifugal pump shafts as well as on oscillating and rotating rods of other equipment is minimized by J-M Centripac. This is because the square cross section of this packing provides the maximum contact surfaces. Thus, it insures a tight seal with the least friction and gland pressure.

Because Centripac is plaited square it retains its shape indefinitely, thus maintaining maximum surface contact for long periods of time. It is made from long-fiber asbestos yarn, thoroughly lubricated and graphited. It seals against fresh or salt, hot or cold water, oil, ammonia, brine, gasoline, and certain weak acids and other chemicals. Because of its wide application, it is a favorite of plant men everywhere.

For general service, Style #7 Centripac is recommended. It contains no wire, is soft enough to conform readily to the packing space, and stands up well in service. It comes in coil form, Style #C-7 and Ring form, Style #R-7. Sizes 3/16" and up.

For higher shaft speeds, J-M Plastic Packings reduce friction and scoring of shafts and sleeves

Higher centrifugal pump speeds make friction increasingly important in packing and shaft life. That is why J-M Plastic Packings have been designed to have the homogeneous structure and low friction so essential to long packing life in this service.

The exact composition of these packings varies according to the service conditions for which each particular style is designed. As an example, one of these, Style No. 610 is an excellent general maintenance packing for service against steam, air, ammonia, gases, etc. up to 550F. It is made of selected asbestos fiber mixed with pure graphite and a small amount of non-friction metal, then bonded with a heat-resisting compound to form a pliable coil or spiral. It is furnished in sizes of 1/8" and up.

YOUR J-M PACKING DISTRIBUTOR will gladly recommend the right packing for your equipment, and furnish it from stock for your immediate requirements. Write Johns-Manville, Box 60, New York 16, N. Y. for his name and address. In Canada, 199 Bay St., Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PACKINGS and GASKETS

More TECHNICAL BRIEFS

Begins on page 160

nor supersede rotating or electronic types, but, because of a number of particular advantages, they fill a gap between the two and are often used where one or a combination of both were previously used. Also, magnetic amplifiers can be combined with either rotating or electronic amplifiers. Such combinations have particular advantages for specific applications.

A magnetic amplifier can be described as a variable reactor between a source of ac voltage and a load. A small amount of control power varies reactance by saturating magnetic core and controls large power to load. Fig. 2 p 160, shows a diagram that can represent a number of possible core and coil arrangements. First, it represents two distinct and separate reactors having their load windings in parallel and control windings in series. It also can represent two separate cores with separate load windings but with a common control winding, or a three-legged core.

Magnetic amplifiers have the following advantages:

1. They are static devices. Long life and minimum maintenance associated with reactors and dry-type rectifiers can be expected, no periodic maintenance being necessary.

2. Reactors and rectifiers are highly resistant to shock.

3. No warm-up is necessary since magnetic amplifier is immediately operative when power is turned on.

4. Control windings are electrically isolated, thus isolating control signal. In addition, this permits independent adjustment of control signal effects and wide variations of impedancies for various signal sources.

5. Control windings are electrically insulated from power winding. Cascading of magnetic amplifiers to form multi-stage units is easily accomplished.

6. Magnetic amplifiers are panel mounted and factory wired, therefore they are easily installed.

7. Circuit parts used with magnetic amplifiers are relatively small. Control rheostats for high-gain units can fit into pushbutton stations and devices for system damping can be placed readily on magnetic-amplifier panels.

8. High-frequency supply voltages can be used, thus regulating system design is simplified and performance improved.

9. Magnetic amplifiers are flexible. A few ratings in a line of high gain toroidal reactors and a few in a line of wound, cut-core reactors can be used, individually or in combination, to build regulators having a wide range of power gains and outputs.

Their disadvantages are:

1. They have a time delay, depending on supply frequency. These delays generally must be considered when designing regulating systems, unless high-frequency supply voltages are used.

2. They require signal power.

3. They are sensitive to changes in supply frequency and voltage.

4. Single-channel designs with dc output are inherently uni-directional in output—not always a disadvantage. Two-channel magnetic amplifiers are more complex, and there are limits to their applications.

5. Single-channel magnetic amplifiers have a minimum load-current. They are temperature-sensitive to a degree, but this is not critical except for a high-gain amplifier subject to wide temperature variations.

The many successful applications of magnetic amplifiers show that their advantages are apparent not only to regulating system designers, but also to ultimate users, since their disadvantages can be reduced by proper design and application. It is the author's opinion that range of applications and any limitations referred to in this paper are representative of present practice and that the art will continue to grow. *AIEE conference paper, available from the author.*

Industrial Regulating System Using Rotating Regulators. *By G E Shaad, Industrial Engineering Section, General Electric Co, Schenectady, New York.*

Basically, rotating regulators are either of the amplidyne type "armature reaction excited," or of the self-energized type such as the *Regulex*, *Rotatrol*, or *VSA* units, where a shunt or series field, or a combination, is used to provide most of the required excitation. Although they differ greatly in design fundamentals, all types provide equipment that can be controlled by a very small excitation.

Amplidyne design, Fig. 3, p 160, has a laminated dc machine structure with a pair of short-circuited brushes, a pair of load brushes, a compensating winding and one or more control fields. A very small amount of control excitation establishing a small flux can circulate full-load current through the short-circuited brush. This current sets up a large armature-reaction flux and resultant voltage is used for load circuit. Because current flow in load circuit would produce an armature reaction opposing the control field flux, a compensating winding is used to maintain control flux under load conditions.

Since rotating regulator systems are not particularly light or small, they may not be satisfactory for some applications. Definite control power is necessary. In general, systems seldom use less than 3 or 4 watts of control power, usually use 30 to 40 watts. Either magnetic or electronic preamplifiers may, however, readily be used to reduce the control power as far as necessary.

Although rotating regulators are of extremely fast response, they do involve a time constant that must be considered in complex systems. In general, the flexibility of rotating regulator systems is excellent, but since they require excitation power, major system changes require considerable material.

Each rotating amplifier is nothing more than a small dc generator with its commutator, brushes and bearings. Properly maintained, and under reasonable conditions of operation, a life of 20 years can easily be obtained.

Perpetual-motion rotating amplifiers are not available, but the stored energy of rotating equipment is used in many places to overcome difficulties that might develop in case of loss of ac power. Since any rotating regulator is controlled through its magnetic circuit, it is easy to provide system isolation. Such isolation increases control-power requirements, but presents little difficulty for normal regulating problems.

Ability of rotating regulators to be self-filtering, and thus sensitive to only average value of input signal, eliminates any input signal-filter problem. Inherent ability to reverse polarity with nothing more than reversal of excitation polarity is an outstanding advantage of rotating regulators. On reversing systems, such as log-carriage drives, arc-furnace con-

(*Continued on page* 200)

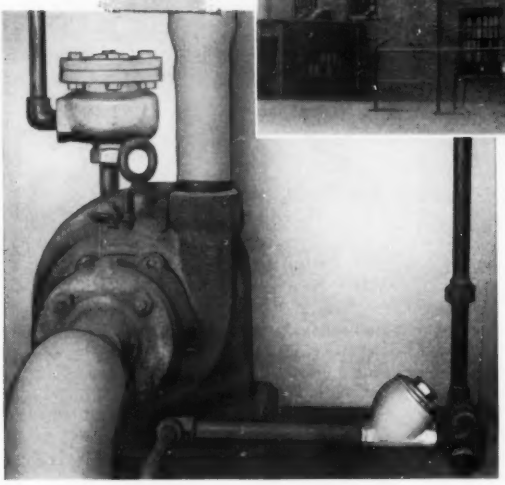
TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from sources, not POWER.

American Institute of Electrical Engineers, winter general meeting, Jan 18-26, Hotel Statler, New York, N. Y. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, N. Y.

American Society of Mechanical Engineers, annual meeting, Nov 29-Dec 4, Hotel Statler, New York, N. Y. Identified by initials ASME and obtaintable through ASME, 29 W 39th St, New York 18, N. Y.

NICHOLSON TRAPS SELECTED FOR *Celanese* STEAM PLANT

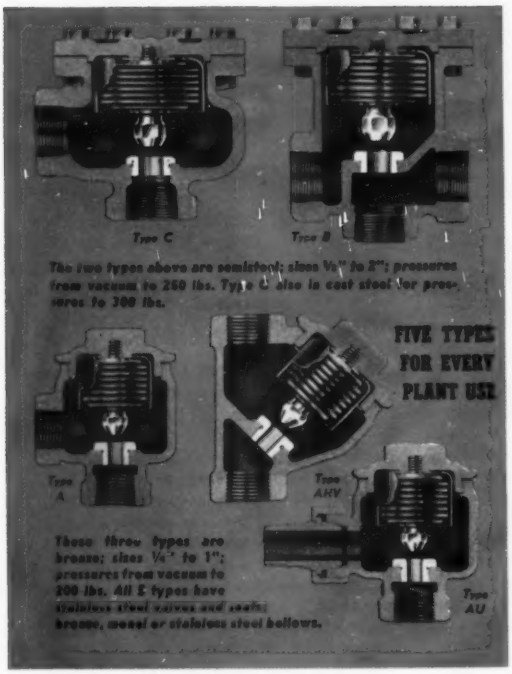


Above, enlarged steam generating facilities of the Celanese Corporation of America plant at Hopewell, Va., now in an extensive expansion program. Specified were Nicholson Steam Traps, two of which are shown at left.

How to use modern equipment to bring the steam generating capacity of a boilerhouse up to the needs of an extensive plant expansion program was recently demonstrated by Celanese Corporation of America at its Hopewell, Va., textile plant.

Stoker equipment to fit present space, and auxiliary equipment of the most modern nature -- all were selected with a view to attaining maximum efficiency, and desired capacity with a margin of space for further expansion. Nicholson Steam Traps were installed in connection with a new piping system which features return of the condensate and reclamation of most of its heat.

A recent survey showed these Nicholson features to be reasons why an increasing number of leading plants are standardizing on Nicholson thermostatic traps: 2 to 6 times average drainage capacity; shorten heat-up time. Operate at lower temperature differential; fast action keeps equipment full of live steam. Maximum air-venting capacity. Types for every process, power and heat application.


Type C
Type B
The two types above are semisteel; sizes ½" to 2"; pressures from vacuum to 250 lbs. Type C also in cast steel for pressures to 300 lbs.
FIVE TYPES FOR EVERY PLANT USE
Type A
Type AHV
Type AU
These three types are bronze; sizes ¼" to 1"; pressures from vacuum to 200 lbs. All 5 types have stainless steel valves and seats; bronze, monel or stainless steel bellows.

Send for
CATALOG 953

A 32-page standard reference; contains installation diagrams and data for determining proper size of trap.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

125 Oregon St., Wilkes-Barre, Pa.

Sales and Engineering Offices in 53 Principal Cities

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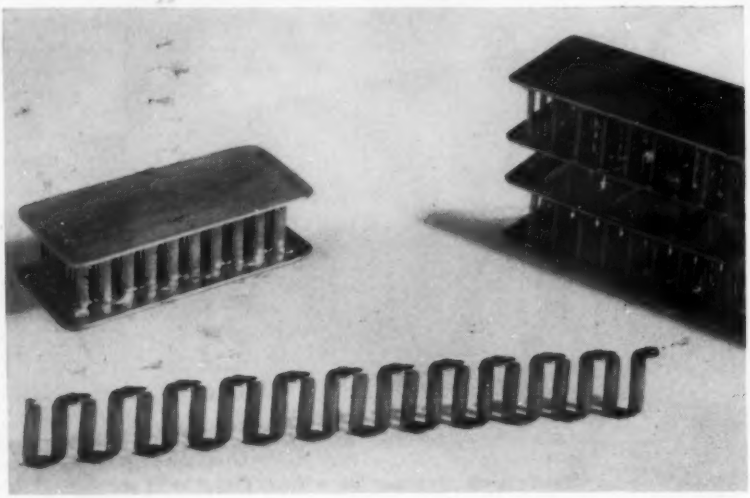


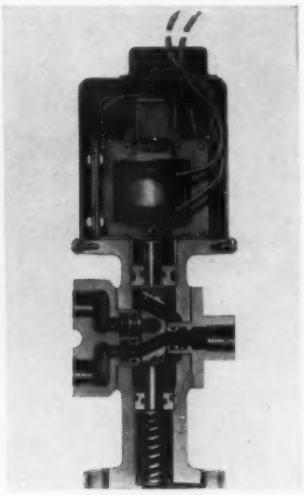
Pin-Fin Heat-Exchanger Surface Is Compact, Light in Weight

501 • Developed for gas-turbine regenerators, new pin-fin surface offers advantages wherever compactness and light weight are important. Pins, that may be either circular in section or streamlined, are machine-formed in continuous strands, with lugs for brazing to plates. Brazing, of either copper or *Nicro* type, is done in reducing-atmosphere furnaces. Such production methods are expected to make the cost of this surface competitive with more conventional types.

The surface will be available in single envelopes or as brazed bundles with as many as 20 or more passages. Round or streamlined pins can be used in each passage, or alternated with strip fins (element at right in photo). Plate spacing can be varied as desired.

In addition to the compactness and lightness resulting from the basic design, use of streamlined pins makes for small frontal area requirements due to low friction factor and very little form drag. Further details are available on request to manufacturer.

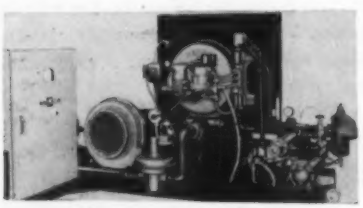
Ferrotherm Co, 1861 E 65th St, Cleveland 3, Ohio



Solenoid Valves for Oil

550 • New series of valves is designed for 0 to 250 psi oil service in industrial applications. Unit incorporates patented *Shear-Seal* principle that has already won wide approval in other models. *Shear-Seals* are self-lapping and wear compensating so that sealing qualities improve with use. Pipe sizes of ¼, ⅜ and ½ in. are available in 4-way, 3-way and shutoff models for 110, 220 or 440 v ac.

Barksdale Valves, 5125 Alcoa Ave, Los Angeles 58, Calif.

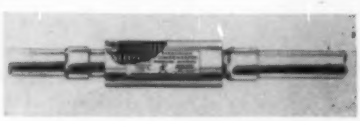


Packaged Burners

506 • New packaged gas, oil and combination burners for commercial-industrial heating and power applications are completely assembled, wired, piped and tested at factory. Components are integrally mounted on heavy structural steel base. This series includes seven stock sizes. Each unit has enclosed electrical control panel and forced draft fan that will deliver necessary air against positive furnace pressure. Full details and specs available on request to manufacturer.

Petro, 3170 W 106th St, Cleveland 11, Ohio

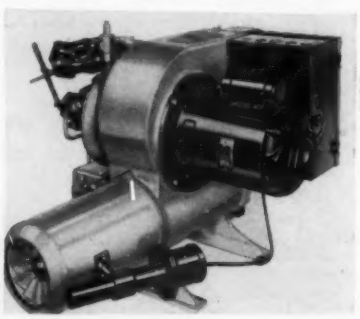
For more data on these items, use post cards p 173. Identify your request with item number.



Expansion Compensator

513 • New expansion compensator for hot water and steam heating systems requires no maintenance or adjustment and will stand up as long as system. Unit is a phosphor-bronze bellows protected by floating brass shroud that also helps guide strokes of bellows in straight line. Device may be installed in steam or hot water lines carrying pressures to 40 psi and temperatures to 250 F. Piping must be accurately guided and well-supported adjacent to each end of unit. Further details available on request to manufacturer.

Flexonics Corp, Maywood, Illinois



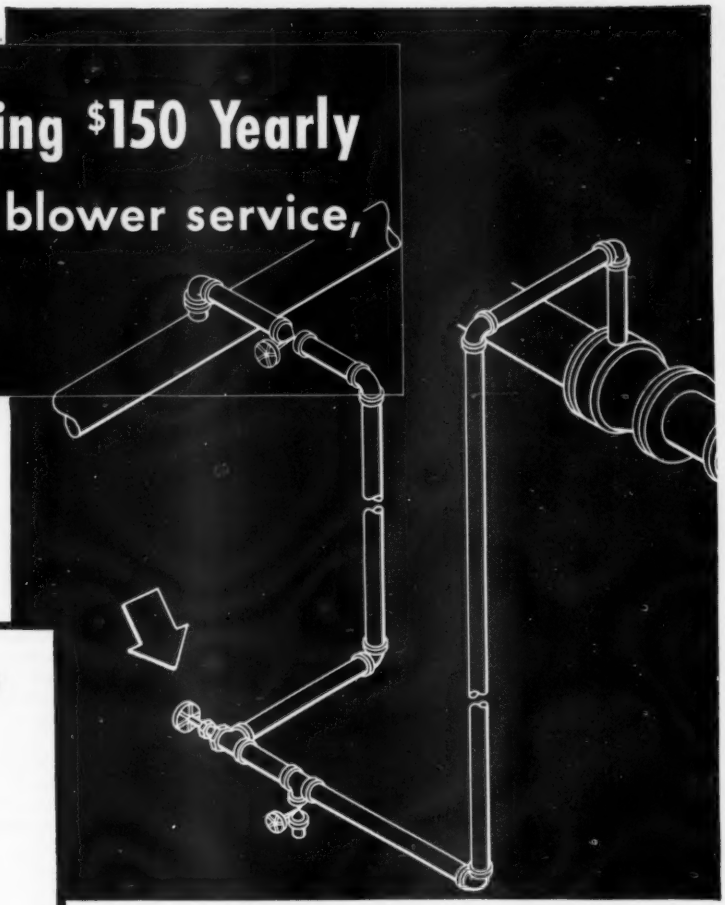
Oil Burner Uses Heavy Fuel

516 • New *"4" Hey-E-Oil* Burner with 35% capacity increase is expressly designed for heating buildings having more than 1500 sq ft of radiation area or using more than 6000 gal of oil per year. A low-pressure, air-atomizing type burner, this unit is reportedly the only modern all-electric ignition oil burner designed to use low-cost No. 4 or 5 oil without preheating. Manufacturer claims this burner effects savings of 25% or more on fuel bills. Full details of design and operation available on request to manufacturer.

Cleaver-Brooks Co, Milwaukee 12, Wis.

Single Valve Saving $150 Yearly

. . . on severe ash blower service, for example . . .



The Installation

At City Light & Power Company, Washington, Indiana—with Crane bronze angle valve in 2-inch steam line to boiler ash blower manifold. Working pressure: 300 psi, 525 degrees F.

Valve Service Ratings

SUITABILITY:
Perfect match for needs

FEATURES:
Crane Plug Type Disc

MAINTENANCE COST:
One stem replaced in 3 years

SERVICE LIFE:
Already 12x former valves

OPERATING RESULTS:
Over $400 saved to date

AVAILABILITY:
Crane catalog item—No. 384P

The Valve

Crane plug-type disc and seat design make a most effective seating combination for tough steam service. Highly resistant to damage by foreign matter, wire-drawing, erosion, cutting, galling, etc. The wide tapered disc allows fine, accurate throttling. These rugged bronze valves come in globe and angle patterns; see your Crane Catalog or Crane Representative.

The Case History

Valves formerly had to be replaced every 8 to 12 weeks, their cost alone exceeding $150 yearly. It's a tough spot even for a good valve.

The valve's location in the steam line is below the boiler water level. Each operating cycle exposes it to a long leg of condensate, with an abrupt change to hot steam direct from the boiler header. On closure, the valve is again subject to cooling, and that's the cycle about 8 times daily.

Under those conditions, this Crane No. 384P Bronze Plug Type Disc Angle Valve put a stop to former replacement cost, saving more than $400 in 3 years since installed. Still the valve remains tight, dependable, and fully fit for service. That's the result of choosing the right valve—the choice assured by Crane quality and the completeness of the Crane line.

THE BETTER QUALITY . . . BIGGER VALUE LINE . . . IN BRASS, STEEL, IRON

CRANE VALVES

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Branches and Wholesalers Serving All Industrial Areas

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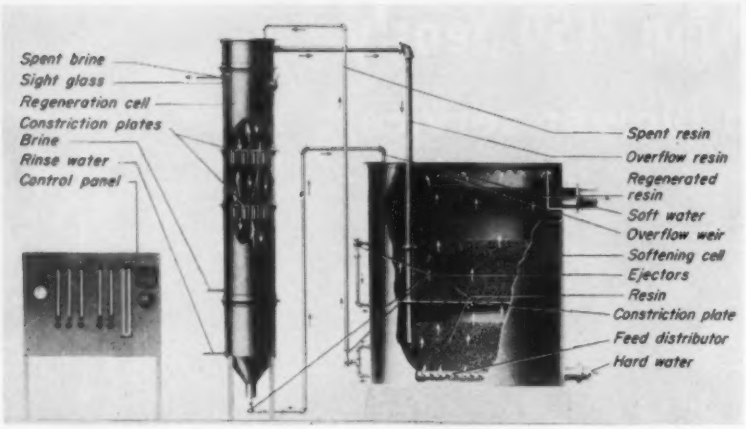
More EQUIPMENT NEWS

Begins on page 164



New Water Softener Eliminates Batch Operation

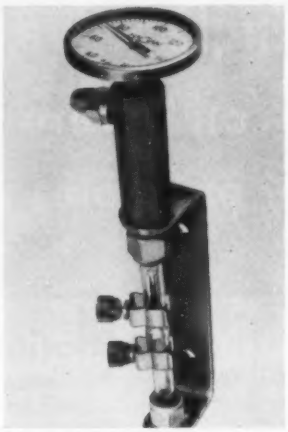
500 • New *Hydro-Softener* provides continuous softening of process water containing 200 ppm or less total hardness. From such quality water, unit will produce an effluent containing less than 5 ppm hardness. Softening is achieved by a base exchange resin, a portion of which is continually regenerated in a separate column to eliminate batch operation.

Equipment consists of two elements: a two-compartment softening cell and a five-compartment resin regeneration cell, both of cylindrical welded-steel construction. In addition, panel-mounted controls provide regulation of resin transfer, brine and wash-water flows and measurement of regenerated resin purity. The two compartments in the softening cell are separated by a perforated diaphragm and each contains an equal amount of base exchange resin. Steel plates fitted with pipe nipples define the five compartments of the regeneration cell through which resin flows continuously.

Manufacturer claims greatest advantage of *Hydro-Softener* lies in its uninterrupted production of treated water of constant quality. Initial costs are lower than those of conventional base exchange softeners because of smaller amount of resin required, minimum of control instruments and reduction in number of steel tanks. Greater use of brine and smaller amount of rinse water required after regeneration reduces operating costs slightly.

Manufacturer states a single unit will treat between 75 and 800 gpm, depending on combination of various size cells and amount of hardness in raw water. Softening cells are available in sizes ranging from six to 12 ft in dia in two-foot steps. Regeneration cells are 15, 22 and 30 in. in dia. Further details available from manufacturer.

The Dorr Co, Barry Place, Stamford, Connecticut

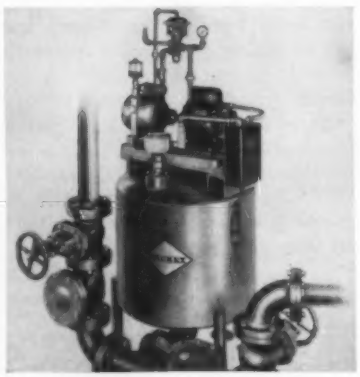


Conductivity Flow Cell

548 • New compact conductivity flow cell features easy removal for cleaning and inspection. Assembly, used in conjunction with conductivity meter or recorder, determines electrical conductivity of condensed steam and feedwater. Instrument is available with cells of various constants. Bimetallic dial-reading thermometer is standard component. Details available on request to manufacturer.

Hagan Corp, PO Box 1346, Pittsburgh 30, Pa.

For more data on these items, use post cards p 173. Identify your request with item number.



Pneumatic Sewage Ejector

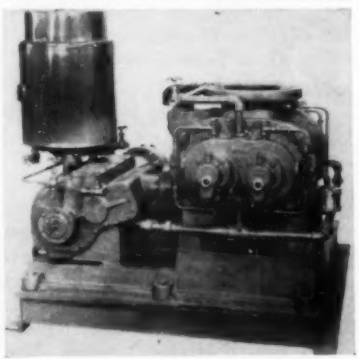
508 • Packaged pneumatic ejector for low flows is designed especially for small building subdivision lift stations. Unit provides dependability associated with pneumatic ejectors at price that is competitive with centrifugal pumps. A completely sanitary unit, *Packex* has hermetically sealed pot to eliminate odor and gas. Simply designed, it has no bearings in pumping unit, no stuffing boxes and no shafting. Capacities range to 20 gpm with 20-ft head. Inlet and discharge fittings may be either 3 or 4 in. Full details on construction and installation available on request to manufacturer.

Yeoman Bros Co, Melrose Park, Ill.

Duo-Test Port Valve

552 • New duo-test port valve provides means for permanent gauge port on hermetic units. It can be mounted quickly and easily in any position. Unit has ¼-in. male flare; tubing sizes are ¼, 5/16 and ⅜ in. OD. New swivel tee is for use in hard-to-get-at spots on modern hermetic systems, provides means of installing pressure relief valve or gauge quickly and easily. Male and female flares range from ¼ to ⅜ in. Pipe sizes range from ⅛ to ⅜ in. Special literature available on request to manufacturer.

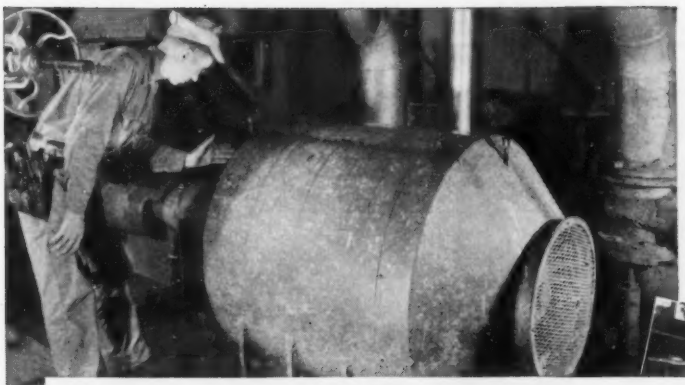
Madden Brass Products Co, 1111 N Franklin St, Chicago 10, Ill.



Booster Vacuum Pump

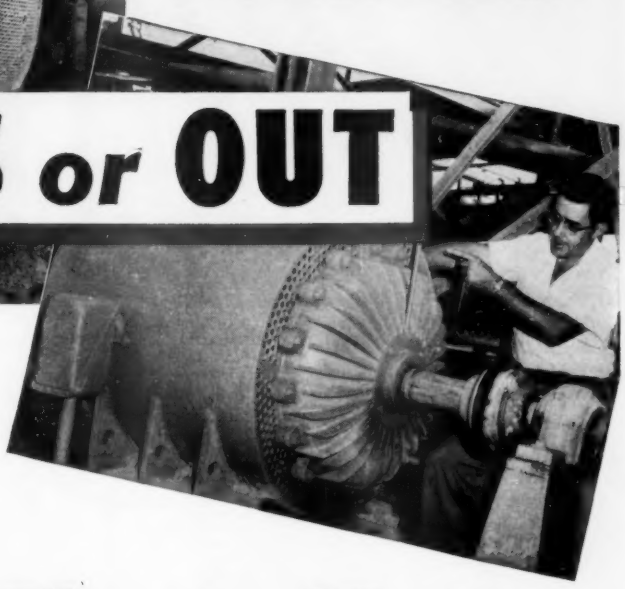
528 • New mechanical booster vacuum pump is designed for use as high-vacuum stage in low-pressure range where single-stage vacuum pumps have poor volumetric efficiency. Model MB is a rotary positive-displacement pump equipped with mechanical shaft seals. As a vacuum booster pump, it is especially designed to exhaust into inlet of a Kinney single-stage pump and to act as a second-stage or backing pump. Unit is unique in that it uses no sealing fluid. Being free of volatile materials, MB booster acts as positive-displacement compressor to retard backstreaming of oil vapors into vacuum system. Full details on design and performance available.

New York Air Brake Co, Kinney Mfg Div, Boston, Massachusetts



ALLIS-CHALMERS
Totally-Enclosed
Fan-Cooled
MOTORS

INDOORS or OUT



DIRT and CORROSION

Can't Hurt These Motors

Here is a totally-enclosed type of motor that will solve many of your dirt and corrosion problems. Install anywhere, indoors or out.

Cooling System is Self-cleaning

Cooling air is carried through the heat-exchanger tubes with sufficient velocity to expel practically any kind of dirt. If oily or sticky dirt should cling, tubes can be ramrodded clean in a few minutes because tubes are straight and tube ends are exposed.

Choice of Corrosion-resistant Materials

You can lick corrosion with this motor, too. Tubes are available in a variety of materials to meet practically any corrosive atmospheric condition. Allis-Chalmers tube-type motors have long and successful experience in such difficult applications as caustic plants, refineries and petrochemical plants, power plants with fly ash problems and many others.

Next time you need a motor for a dirty or corrosive location or for outdoor operation in all kinds of weather, call your Allis-Chalmers District Office. Get complete information on Allis-Chalmers tube-type totally-enclosed, fan-cooled and explosion-proof motors. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7149. Available in ratings on frames larger than NEMA 505 up to 3000 hp. A-4222

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

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Applied . . .
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CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE V-belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral types from ¾ in. to 72 in. discharge and up.

ALLIS-CHALMERS

More EQUIPMENT NEWS

Begins on page 164

This 85% Magnesia Insulation Is Water Resistant

502 • Magnesia Insulation Manufacturers' Assn has announced development of an 85% magnesia insulation that will withstand normally destructive effects of hot or cold water indefinitely. Material is to be used where underground pipe lines are subject to flooding, for process equipment and piping requiring hosing or washing down and on outdoor runs in wet climates.

Results of subjecting both conventional (specimens A, B, C & D) and water-resistant (specimen E) 85% magnesia to water-resistance tests are shown above. Tests on these hot steam pipes consisted of 30 cycles (24 hours each) of boiling water immersion and alternate drying, plus 168 hours of continuous immersion. New type 85% magnesia shows only slight roughening of surface. Joints are in good condition, and there is no appreciable shrinkage. Conventional insulations show various degrees of disintegration.

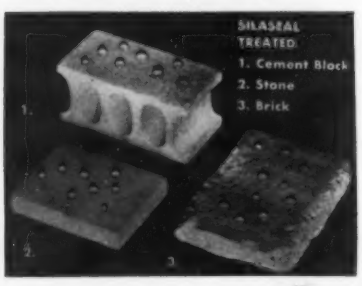
For all practical purposes, water repellent additive in new material does not affect conductivity, density, or other vital properties of the insulation. Conventional 85% magnesia will continue to be the industry's standard and the new water-resistant material will be offered where severe moisture problems exist or when specified by user. Further details are available from insulation manufacturers or from the association.

Magnesia Insulation Manufacturers' Assn, 1317 "F" St NW, Washington 4, D. C.

Safety Topping

532 • Non-slip safety topping for use on steps and floors is a synthetic, heavy-bodied plastic material containing special solvents and abrasive fillers. It forms a thin tightly-bonded veneer that is slip-proof, wet or dry. Easily troweled on, *X-L Veneer* can be used over concrete, wood, steel, tile, mastic or terrazo floors. It is impervious to oil or grease and is available in tile red, green and gray. Bulletin C-46-5.

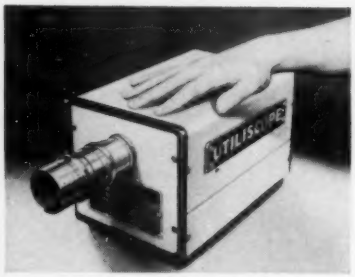
Monroe Co, Inc, Cleveland, Ohio



Masonry Coating

505 • Newly developed *Surfco Silaseal* formula reportedly kills fungus, damp mold and mildew, makes surface water repellent and does not alter natural appearance. Material deposits water-repelling silicones to a depth of ¼-in. below surface, depending on porosity of masonry. *Silaseal* is packaged in one and five-gal cans and 30 and 55-gal drums. Full details available.

Surface Protection Co, Inc, 16852 Euclid Ave, Cleveland 2, Ohio



Industrial TV Camera

546 • New model *300-BV* camera is available for industrial television installations where a smaller camera having high resolution and using lower lighting levels is desirable. It can be used instead of, or interchangeably with, standard *Utiliscope 300-B* camera. Unit may be placed in any location, no matter how remote, dangerous or inaccessible. One or more viewing screens are located wherever convenient to operator. Applications include: viewing water level and furnace conditions in big power boilers, observing interiors of steel heating furnaces, watching dangerous and destructive tests, guarding plant gates, supervising manufacturing operations and inspecting sensitized film. Further details available in bulletin 1136A.

Diamond Power Specialty Corp, Lancaster, Ohio

Rail Skids

519 • Rail skids with precast concrete supports simplify yard storage of heavy materials. Skid consists of railroad rail, cut to length, and precast concrete supports with anchor bolts cast in place. To assemble skid, concrete supports are spaced at desired intervals and rail is simply fastened down with Foster rail clips. In addition to supplying rails and rail clips, manufacturer will furnish drawings and instruction sheets for casting concrete supports and assembling units.

L B Foster Co, Pittsburgh, Pa.

For more data on these items, use post cards p 173. Identify your request with item number.

Dust Collector

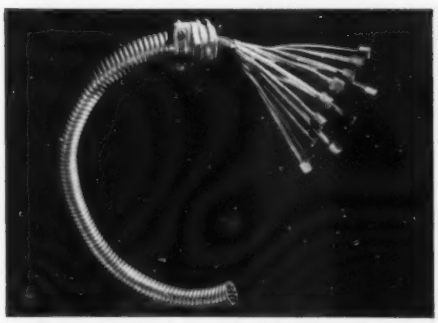
553 • New *AMERjet* dust collector is a reverse-jet fabric unit designed for applications where extremely fine particles are involved or where material must be collected in dry state for reclaiming. Method of media reconditioning permits higher velocities through tubes, reduces amount of cloth needed for any given cfm. Full details available in manufacturer's bulletin 279.

American Air Filter Co, Inc, Louisville, Ky.

For the new pneumatic instrumentation

Cabled Tube

The recent tremendous increase in the use of tube instead of wires for instrumentation and control purposes has led to an important new development—cabled tube. This is an armored group of long tubes twisted together to permit bending without distortion. An insulating tape is wrapped over the bundle of tubes to prevent electrolytic action. Then interlocking, flexible galvanized steel armor is applied, like BX. This protects the tubes from injury during shipment, storage, installation, and in service. Standard fittings, boxes and cabinets can be used for junction boxes and terminations. To make it possible to readily identify each tube, one tube in each layer is colored; the position of each tube in each layer in relation to the coded tube

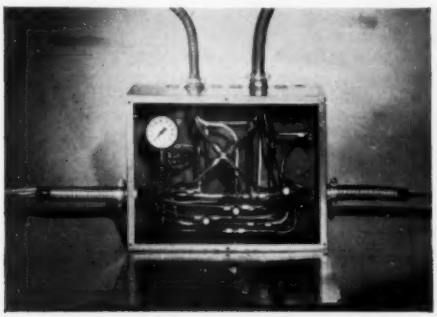


remains the same throughout the length of the cable.

The tubes usually are copper, but aluminum tubes can be used for special purposes. For unusually corrosive situations, a plastic outer sheath can be applied. As many as 19 tubes, ¼" OD, can be cabled, and supplied in lengths up to 1,000 ft.

Showing the construction of Crescent Armored Multitube, made by Crescent Insulated Wire and Cable Co., Trenton 5, N. J., which will supply further information on request.

Since the tubes carry not electricity but air, nitrogen, helium, or a fluid, they are especially attractive in potentially explosive locations, as in refineries and chemical plants. Utilities are also turning decisively to this new cable, while automatic process control (automation) is a rising application.



Revere, as a supplier of tube for this purpose, calls this cabled tube development to your attention as a matter of general and perhaps specific interest. See Revere for copper, aluminum and brass tube and pipe, electric welded steel tube, and lockseam tube. Call the nearest Sales Office.

REVERE

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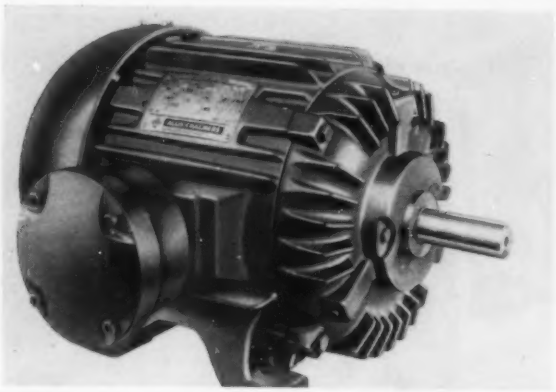
More EQUIPMENT NEWS

Begins on page 164



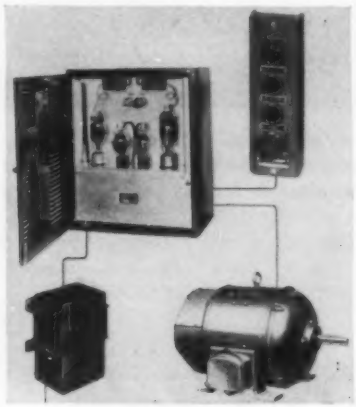
New Line of Motors Meets Latest NEMA Standards

503 • Complete new line of ac squirrel-cage induction motors in frame sizes 326 and smaller follows recently established NEMA standards and marks first major change in frame reassignment for these sizes in 25 years. New units, designated *Type G*, will retain all important features of earlier line while offering improvements inherent in redesign.

Construction-wise, new models will have cast iron frames and end shields. Rotors will be pressure-cast from aluminum. Bearings will be grease-lubricated, medium series, double-shielded ball bearings capable of relubrication without dismantling motor. Stator windings will be random or mush-wound type of heavy *Formvar*-coated wire in semi-closed slots. Stator will receive multiple dips and bakes to insure protection against moderate amounts of moisture, weak acids and alkalies.

All continuous-rated totally-enclosed motors under new design will be fan-cooled. New units will be available initially in frame sizes 182 and 184. Larger sizes will become available at approximately five-month intervals. Full details on design and construction are available in manufacturer's bulletins 51B6210E, 51B7225B and 51B7286D.

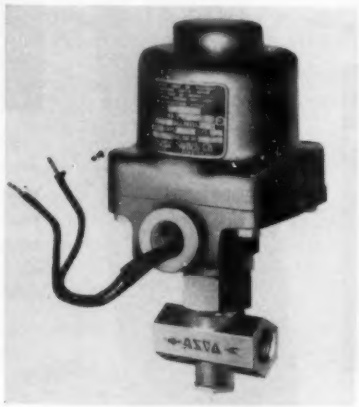
Allis-Chalmers Mfg Co, Milwaukee 1, Wisconsin



Adjustable-speed Drive

545 • New stepless adjustable-speed drive is designed for operation from ac power lines and is available with dc motors in standard NEMA frame sizes, ¾ to 15 hp. Advantages of this drive are: precision speed control, unusually wide speed range where required, adaptability to variety of optional electrical and mechanical modifications, use of new and simple but reliable electronic circuits. Unit is available with speed ranges of 5:1, 20:1 or 50:1, with 100:1 for special applications. Full details in manufacturer's bulletin 1500.

Louis Allis Co, Milwaukee 7, Wis.



Solenoid Valves

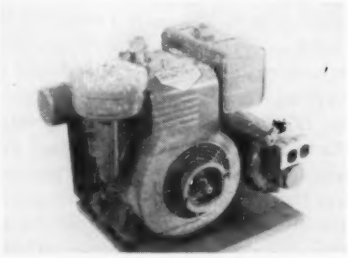
512 • New variations in standard 2-way bronze and brass solenoid valves makes these units suitable for handling corrosives as well as steam up to 450 F. Valve 8269 is equipped with explosion-proof solenoid to be used for Class I Group D Hazardous locations. Bodies are either stainless or steel; all trim is stainless. Both types are packless with no sliding glands or stuffing boxes. Pipe sizes are ⅜ and ½-in. for both valves; orifice diameters range from ⅛ to ⅜ in. Manual operators can be supplied with all except ⅛-in. orifice type.

Automatic Switch Co, Orange, N. J.

Heavy Duty Magneto

542 • New heavy-duty magneto features compactness and increased power. Although of only medium size, Type MRF magneto has even greater output than larger heavy-duty units. Secret of stepped-up output lies mainly in use of more powerful *Alnico* magneto material. Extra stamina results from rugged construction and use of ball bearings on both ends of magnet rotor and double-row bearing on distributor rotor.

American Bosch Corporation, Springfield, Massachusetts



Electric Generator

547 • New model B-2000 hand-portable, engine-driven, electric generator plant offers more power in less space at lower cost with greater versatility than any conventional unit in its power range, according to manufacturer. Unit will provide both electrical and mechanical power (for belt-driven equipment) simultaneously without removing either generator or engine from steel base. New model has max output of 2500 w; continuous rating is 2000 w, 115 v, single-phase, 60 cycles. Overall dimensions are 17x23x19½ in., weight is 145 lb. Further details and literature available from manufacturer.

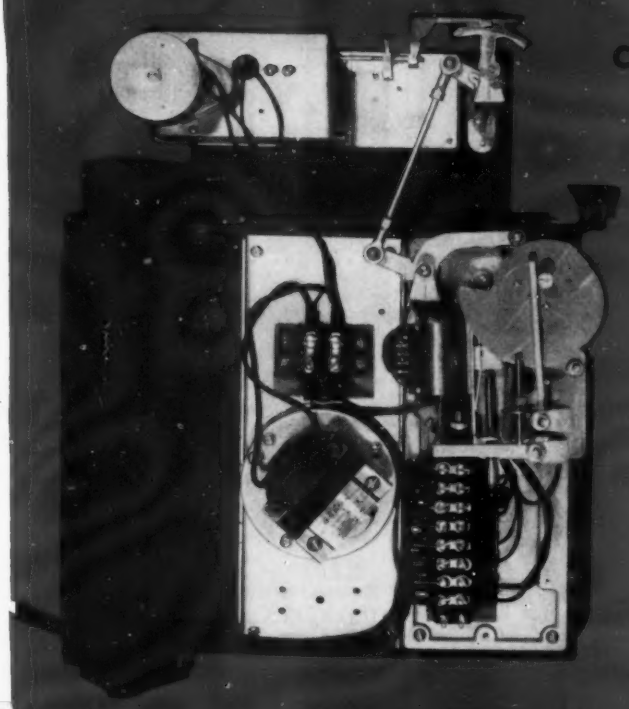
Lynn Engrg & Supply Co, Russ Bldg, San Francisco 4, Calif.

For more data on these items, use post cards p 173. Identify your request with item number.

CHECK THESE TOO . . .

Discharge Silencers . . . . . p 180
Direct Lift Valve . . . . . p 184
Diesels . . . . . p 188
Unit-supported Bus . . . . . p 190
Protection Devices . . . . . p 190
Ring Rheostat . . . . . p 192
Megohmeter . . . . . p 194
Motor Design . . . . . p 196
Motor Control Systems . . . . . p 198
Pipeline Regulators . . . . . p 198

a new electronic flow meter!



Choice of 3 mercury-less transmitters

Hays Barton flow or differential transmitter

Hays differential transmitter

Hays liquid level transmitter

continuous integration —no creep at zero

unaffected by normal voltage, frequency and temperature changes

electronic operation provides high speed and greater accuracy

3 to 1 range calibration at recorder

HAYS Electronic Flow Meter

Since the circuit is of the electronic null-balance type, it is unaffected by normal voltage and frequency variations. Also, neither temperature variations nor reasonable length of transmission lines affect the calibration of the instrument.

The *pen-drive motor* is built for reversing duty. Normal variations in voltage and frequency have no noticeable effect on its operation.

The *integrator* is continuous in operation and simple in mechanical construction. A micrometer zero adjustment for calibration is easily accessible.

Indicators can be calibrated to read directly in rate-of-flow or other factors as desired.

Write today for full information on the Hays Electronic Flow Meter Bulletin 52-1074-222.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION
MICHIGAN CITY 3, INDIANA

ILLCO-WAY ionXchange

serving the essential power plants of American industry

pioneers and leaders in ionXchange

ILLCO-WAY "firsts" include manufacture of the first commercial two-bed De-ionizer . . . the first commercial mixed-bed De-ionizer . . . and the development and building of the first successful installations for the purification of such liquids as beet-juice and crude glycerol by ionXchange . . . In the power field, boiler feed water treatment by ILLCO-WAY ionXchange has long meant lower operating costs and increased operating efficiency. Installations in leading plants.

ILLCO-WAY

DE-IONIZING
DE-ALKALIZING
SOFTENING

For complete data, see Sweet's File, Power Plant

ILLINOIS WATER TREATMENT CO., 853-5 Cedar St., Rockford, Illinois
141 East 44th Street, New York 17, N.Y.
Canadian Distributor: Pumps & Softeners Limited, London, Canada

OUTSIDE the boiler

is the logical place to treat feedwater! An ILLCO-WAY De-ionizer removes objectionable solids the logical modern way . . . by ionXchange . . . economically . . . *before* water enters the boiler.

Remove dissolved solids ILLCO-WAY De-ionizers provide water free of dissolved solids, silica and CO_2. Manual or automatic controls; flow rates to meet plant requirements.

Remove hardness ILLCO-WAY Softeners (manual or fully automatic) provide any required amount of zero-soft water. Compact, economical, easy to operate.

Remove alkalinity ILLCO-WAY Hydrogen Zeolite units reduce alkalinity, soften plant supply. Water with controlled alkalinity and zero hardness to meet requirements.

Send for your free copy...

of Boiler Feed Water bulletin "Treatment X," containing performance data, installation views. Please write on company letterhead. Address: Illinois Water Treatment Co., 853-5 Cedar Street, Rockford, Illinois.

Treatment "X"

ILLCO-WAY

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AIR CONDITIONING

1 **Packaged air conditioner.** Three-color, 12-page booklet. Design and installation photos, complete specs. Bulletin C-1100-B49, Worthington Corp, Harrison, N. J.

2 **Packaged air conditioner.** Two-color, 6-page bulletin. Construction details, performance ratings, complete specs. Bulletin 77-5, U. S. Air Conditioning Corp, 3300 Como Ave, SE, Minneapolis 14, Minn.

3 **Heavy duty fans,** *Series 8000,* for induced draft service. Two-color, 8-page catalog. Photos, construction features. Catalog 1380, Westinghouse Sturtevant Div, Dept 072, 200 Readville St, Hyde Park, Boston 36, Mass.

4 **Heating pipelines,** applications of tubular heaters in industry. Two-color, 8-page booklet. Photos, charts, installation data. Bulletin GEA-5095A, General Electric Co, Schenectady 5, N. Y.

BOILERS & AUXILIARIES

5 **Boiler-burner unit** for oil, gas or combination. Full-color, 16-page catalog. Photos, cutaways, full specs. Catalog 502, Kewanee-Ross Corp, Kewanee, Ill.

6 **Continuous boiler blowoff** heat recovery equipment shows how to save boiler plant fuel and labor costs. Two-color, 8-page folder. Photos, charts, typical calculations. Bulletin WC-114, Graver Water Conditioning Co, 216 W 14th St, New York 11, N. Y.

7 **Combustion control** case history of "exposed" steam generator at Manistee, Mich. Eight-page illustrated booklet. Bulletin R-10, The Hays Corp, Michigan City, Ind.

8 **Desuperheater,** self contained, reduces temperature of steam used for process or auxiliaries. Bulletin 405-C, Copes-Vulcan Div, Continental Foundry & Machine Co, Erie 4, Pa.

9 **Pressure reducing valve.** Twelve-page booklet. Factual data, sectional views. Bulletin 477-A, Copes-Vulcan Div, Continental Foundry & Machine Co, Erie 4, Pa.

10 **Automatic soot blowing.** Sixteen-page booklet. Installation drawings. Bulletin 483, Copes-Vulcan Division, Continental Foundry & Machine Co, Erie 4, Pa.

★ **Duplex tubes** for heat exchangers and condensers. Two-color, 14-page bulletin. Photos, sectional drawings. ★Request direct on company letter head to Bridgeport Brass Co, Bridgeport 2, Conn.

11 **Boiler feed control** performance report covering multi-element feedwater control at Georgia Power Co. Sixteen-page booklet. Bulletin 489, Copes-Vulcan Div, Continental Foundry & Machine Co, Erie 4, Pa.

12 **Soot blowers.** Four-page bulletin No. 1001, Copes-Vulcan Div, Continental Foundry & Machine Co, Erie 4, Pa.

13 **Long retractable blowers.** Air and electric models with dual motor drive. Bulletin 1002, Copes-Vulcan Div, Continental Foundry & Machine Co, Erie 4, Pa.

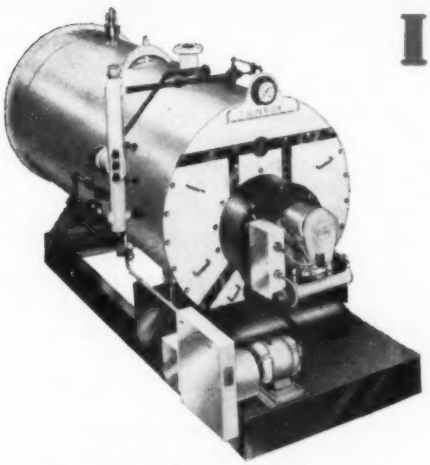
14 **Tank flanges** and water heater adapters. Two-color, 22-page bulletin. Photos, complete specs. Bulletin F-53, Phoenix Mfg Co, Catasauqua, Pa.

CONTROLS

15 **Open drop-out fuse** cutouts for sectionalizing main feeders, switching transformer, capacitor banks and other loads. Two-color, 16-page folder. Photos and specs. Bulletin GEA-1816H, General Electric Co, Schenectady 5, N. Y.

(*Continued on page* 254)

only a TRUE PACKAGED boiler IS TESTED like this.



18 sizes from 20 to 600 b.h.p. for pressures to 250 p.s.i. or for hot water. For complete details write for Catalog 600.

At the Superior factory in Emmaus, Pa., every steam generator is thoroughly tested before shipment. This is one of the outstanding advantages of the *true* packaged steam generator. Completely assembled at the factory with burner and all boiler trim installed, it is set on a testing line, connected to service supplies, and fired. During this test firing period, trained technicians thoroughly check on all points of performance and make whatever adjustments are necessary to bring the unit into top operating condition.

Then, and then only, is a Superior Steam Generator shipped . . . with a written guarantee based on the results of this actual test firing. There's no guesswork about Superior Steam Generators. Every guarantee is based on the actual performance of the unit to which it applies.

for performance you can **BANK** *on*

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR
STEAM GENERATORS

George Edwards' Scrapbook

This thing we call personality includes your appearance, your manners, your voice, your conversation, everything about you that impresses you on those with whom you come in contact as an individual different from every other person in the world. You do not have to be attractive to have a charming personality. You do not need to be wonderfully clever, but you must be careful, courteous, clean, well-informed, ready always to be at your best and to give people your best. Personality has paved the way for fortunes.

—S RONALD HALL

* * *

The man who has not anything to boast of but of his illustrious ancestors is like a **potato**—the only good belonging to him is underground. —SIR THOMAS OVERBURY

* * *

Perfecting his lamp was only the first step for Edison. To compete with the gas jet, he had to perfect the electric generator, conductors for leading current into homes, a way to keep voltage constant in distribution system no matter how heavy the drain, way to prevent short-circuits in distributing lines; practical electrical fittings, a meter to measure customer's consumption and insulation for underground electric cable leading from Pearl Street station in New York City. Incidentally, by 1882 this station provided electricity for 5000 lamps. From 1869 to 1910 Edison applied for 1328 patents.

One headache the lamp gave Edison was that the inside of the glass bulb was turning black. He finally patented a plate device known as "Edison effect" for blocking positive charges in a lamp without interfering with negative charges. Although Edison found no practical use for this "effect," it was responsible for the electronics industry—including television. I guess all of us are pretty heavily in debt to this great scientist.

Did you know that John Ericsson, designer of the Civil War *Monitor*, also invented and built hot-air engines? Thousands of Ericsson hot-air engines were used to pump water on farms to the upper floors of city buildings. In the days before the dependable distribution of electrical power, and the wide application of the electric motor, hot-air engines powered small machine tools, air compressors, and even small factories. The fan held by Frank Taylor of the Smithsonian Institution—though it looks like an electric fan—is turned by a tiny hot-air engine of a late Ericsson type. A spirit burner supplied the power.

The large Rider-Ericsson engine behind the fan works on the same principle. A volume of air expands and contracts under a work piston—as the air is alternately heated and cooled. A loosely fitting transfer piston moves the air back and forth between the hot and cold ends of the cylinder. The same charge of air is used over and over. John Ericsson built one engine with four 168-inch working cylinders and four 137-inch compressing cylinders. It propelled a ship which foundered at the end of its first round trip—New York to Washington—through no fault of the engines.

For my purpose, I always considered the lead pencil with an eraser the world's greatest invention and often wondered how its inventor made out. Now I learn that the United States Supreme Court held that no invention was involved because pencil and eraser did not cooperate to produce the desired result—the pencil and eraser each being used independently of the other.

This comes under the so-called negative rule of invention that attempts to state what does not constitute invention. All I can say is that the good judges might have ruled otherwise had they seen what I produce without the aid of an eraser.

George Edwards
Engineer

ARE CLOGGED LINES LIKE THESE CUTTING YOUR WATER SUPPLY?

Over 1½ Miles of Buried Water Line Chemically Cleaned IN PLACE by Dowell Service

You don't have to dig up water lines in order to clean them! Take the case of a major railroad that had over 8600 feet of *buried* water lines, ranging from 2 to 12 inches in diameter. The capacity of these lines had been greatly reduced by scale deposits. Dowell Service used liquid solvents to clean all the lines, *in place*, during a period of only six days with a minimum interruption in service.

Dowell Service offers *fast*, effective chemical cleaning of pipelines of all kinds—water lines, disposal lines and product lines. And, whether these lines are underground or above, indoors or out, no digging or dismantling is necessary. Dowell solvents are designed to dissolve the accumulated deposits, and are introduced through regular connections. Because they are liquid, Dowell solvents reach wherever steam or water can flow, cleaning places inaccessible by other methods—angles, curves, valves, complicated surfaces and hook-ups. *Experienced* Dowell engineers do the job using Dowell-designed truck-mounted pumps, mixers and control equipment.

Many other types of equipment can also be cleaned chemically by Dowell. If you have boilers, condensers, evaporators, bubble towers, water wells or other operating equipment where deposits are reducing capacity, let Dowell Service *save you time and money in maintenance cleaning!*

FIND OUT ABOUT CHEMICAL CLEANING! There are many places in your plant where Dowell Service can clean equipment faster and better than out-dated mechanical methods. Call your nearest Dowell office for a fact-filled book. Or write direct to Tulsa, **E-23.**

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
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Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED
Tulsa 1, Oklahoma

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

When you need instrument service . . .

Ever have a tire blow out while you're traveling late at night? If it happens near a service station, you're lucky. But if it's on a lonely road far from town, you've got trouble.

When it comes to service on instruments, you don't need to take chances on being lucky. Because when you have Honeywell instruments, you've always got the comfortable feeling that service is close at hand . . . whenever and wherever you want it . . . from the world's biggest instrument service organization.

OVER 110 SERVICE CENTERS

No matter where you may be, there's a Honeywell service man near you. Offices are located in more than 110 cities of the United States and Canada, near every large production center.

When you run into trouble, just telephone or wire the nearest of these offices. You'll get a service specialist promptly . . . often within a few hours. This quick attention to your needs protects your production schedules, and prevents delays that can cause costly stoppages.

TRAINED PERSONNEL

Honeywell service men are thoroughly trained for their important responsibilities. In the Honeywell factories, hand-picked men learn both the theory and practice of instrument maintenance. Then they serve an apprenticeship in the field offices, to gain further first-hand experience. You can be sure that the Honeywell man who calls at your plant is a qualified specialist, well versed in the practical art of keeping good instruments in the best condition.

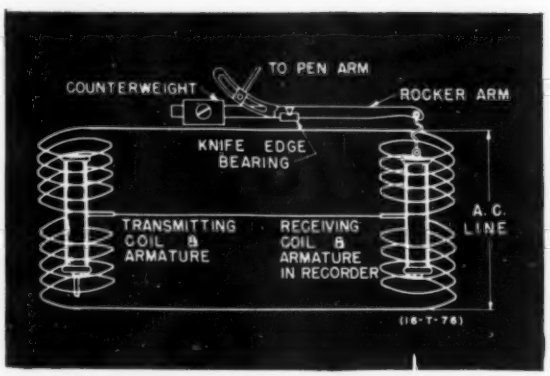
PERIODIC SERVICE

But why wait for emergencies—when you can prevent them with periodic service. Under a simple contract, a Honeywell man will visit your plant at regular intervals to inspect, clean and adjust your instruments and controls. The plan is economical, and can save you hours of production time. Our nearby office will be glad to give full details on Honeywell Periodic Service.

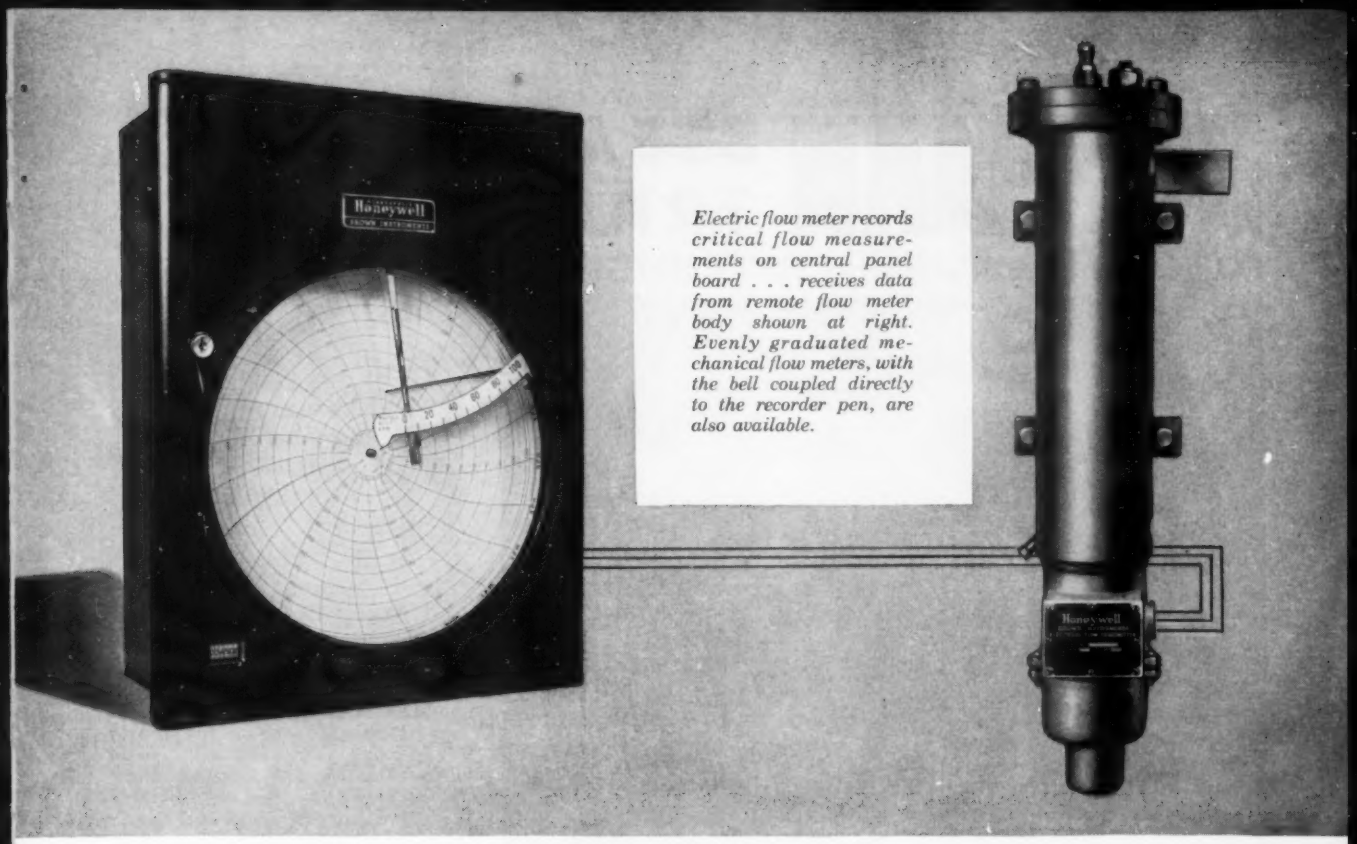
Better accuracy...

greater simplicity

.....for steam



ELECTRICAL TRANSMISSION SYSTEM *brings flow data instantaneously and accurately from the remote meter body to the Brown Flow Meter. The inductance bridge system consists of a transmitting coil and armature at the meter body, and an identical coil and armature in the instrument. The receiving armature faithfully duplicates the movement of the transmitter.*



Electric flow meter records critical flow measurements on central panel board . . . receives data from remote flow meter body shown at right. Evenly graduated mechanical flow meters, with the bell coupled directly to the recorder pen, are also available.

plant flow measurements

WHEREVER your steam plant uses measurement of flow . . . for steam, feedwater, make-up water or oil . . . Brown Electric Flow Meters offer every performance feature you could require. Compare these advantages:

Electronic integration . . . using high-speed, high-sensitivity electronic scanning . . . provides exceptional precision in totalizing flow. This unique integrator completely eliminates friction loading of the recording system. It's extremely simple; has only three major parts, and can be calibrated in only a few minutes.

Electrical transmission . . . ideal for centralized control . . . permits the meter body and instrument to be located hundreds of feet apart without loss of sensitivity. A precision-made inductance bridge transmission system (illustrated on the opposite page) gives faithful reproduction of remote measurements, and eliminates the problems of panel pipe connections.

Evenly divided chart assures easy readability and high accuracy at all flow values . . . no crowding of divisions at the low end of the scale.

Brown Electric Flow Meters are available in both square root and evenly graduated type meters with ranges applicable to practically all steam, water and oil measurements. Your nearby Honeywell sales engineer will welcome the opportunity to discuss your specific needs . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

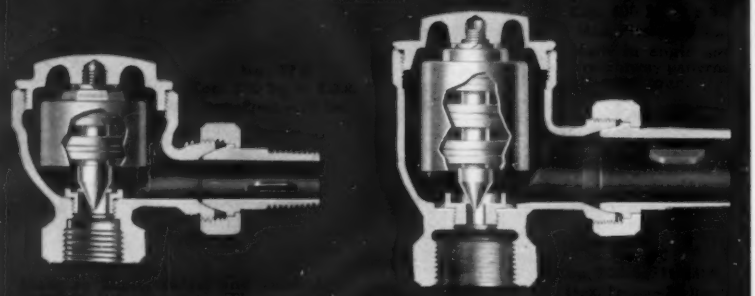
● **REFERENCE DATA: Write for new Catalog 2320, "Flow Meters, Indicating, Recording, Controlling."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

HOFFMAN STEAM TRAPS

FOR LOW, MEDIUM and HIGH PRESSURES

LOW PRESSURE TRAPS

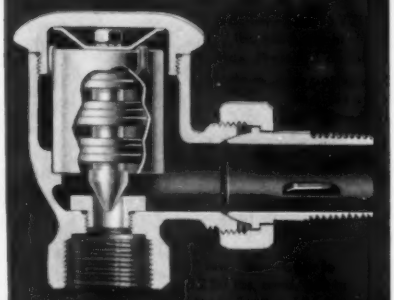


MEDIUM PRESSURE

Thermostat diaphragms are of a special alloy which will not soften or crack from repeated flexings.

Removable thermal units are a distinguishing feature of Hoffman Traps, greatly simplifying clean-out and inspection work.

HIGH PRESSURE



Hoffman offers a complete line of Low, Medium and High Pressure Thermostatic Traps with uniform guarantee of quality and precision workmanship. A full range of sizes and capacities assures you the correct trap for service with radiation, dryers, sterilizers, mangles, cookers and similar uses. Body, cap, nut and tail piece are of high quality brass. Other features of design contribute to long life, low maintenance cost Hoffman service.

HOFFMAN STEAM SPECIALTIES

More EQUIPMENT NEWS

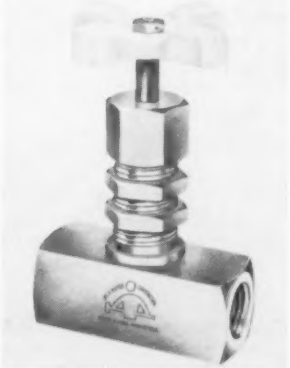
Begins on page 164

Discharge Silencers

534 • New line of Series "ADS" accoustic discharge silencers is designed to eliminate high and low frequency noise caused by high-velocity discharge from steam and air devices. They reportedly set new standards in noise control in critical and non-critical areas by use of patented snubbing principle using specially designed acoustic reactance chambers plus special sound-absorbing material. Units are for use on steam vents and safety valves, hogging jets, gas turbines, air nozzles, evacuating ejectors and similar devices discharging high-velocity gas. Complete data available in manufacturer's bulletin 265.

Burgess-Manning Co, Libertyville, Ill.

For more data on these items, use post cards p 173. Identify your request with item number.



Needle Valve

510 • New panel-mounted needle valve, designed to save both time and money, can be installed in a matter of seconds. All valves in this series are machined from extra-heavy bar stock steel and are designed for max pressures of 10,000 psi with water, oil or gas. Valve bodies are marked in accordance with MSS regulations showing size, material, service symbol and max pressure. Full details available on request.

Jas P Marsh Corp, Skokie, Illinois

(*Continued on page* 184)

BOTH ARE OILS—

BUT ONE'S A MASTERPIECE!

In Lubricating Oil, too, there's no substitute for Quality!

"Look-alikes"—in lubricating oils as in oil paintings—can fool you. But they can't fool a machine. Famous Gargoyle oils prove this point.

You can copy the physical specifications of a Gargoyle oil, but you can't copy the 88 years of experience and skill that transform these specifications into products of unsurpassed quality. Vary the ingredients or the way they're compounded even slightly, and you wind up with an oil that, at best, may do no harm. But neither can it possibly bring you the benefits the original was designed to deliver.

This *inherent quality* is only part of the Gargoyle picture. With it goes the world's greatest lubrication engineering service. We analyze your plant machinery—work with your personnel to set up a complete program of *Correct Lubrication* that will improve your production, cut maintenance costs.

Why accept substitutes for *your* plant?

SOCONY-VACUUM

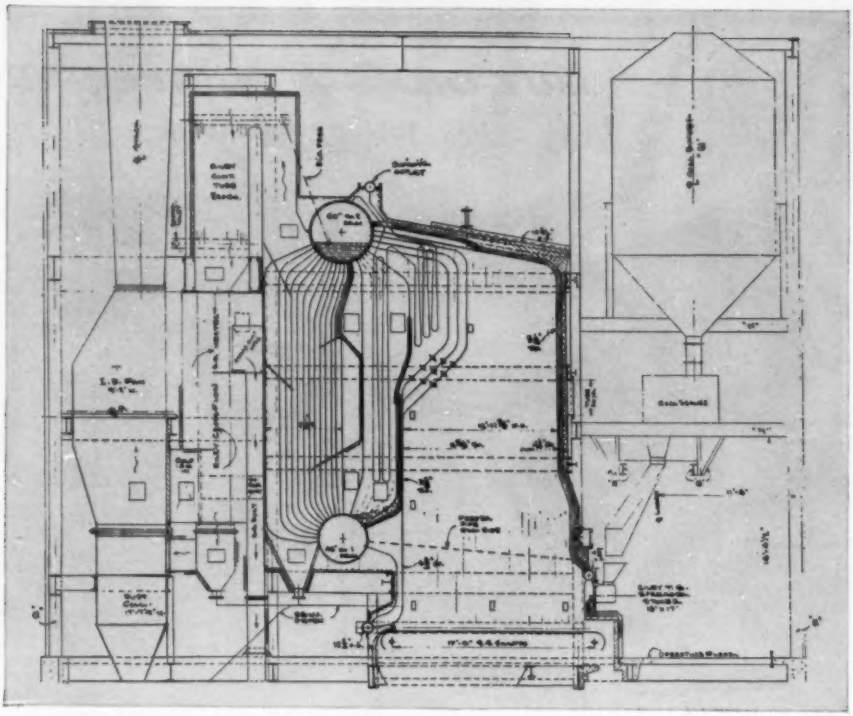
SOCONY-VACUUM

Correct Lubrication

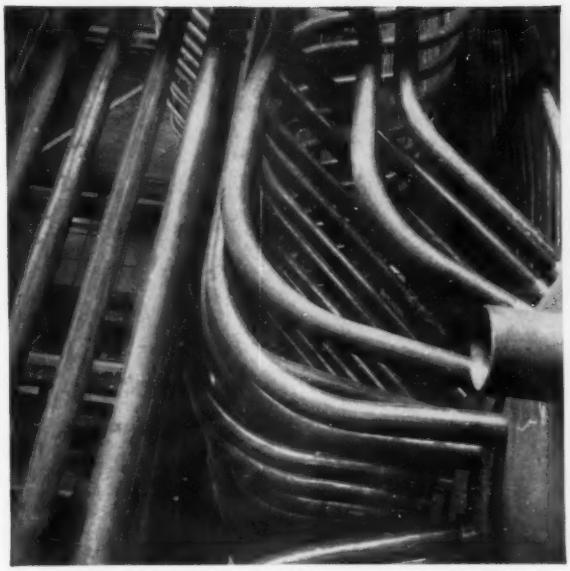
FIRST STEP IN CUTTING COSTS!

SOCONY-VACUUM OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION

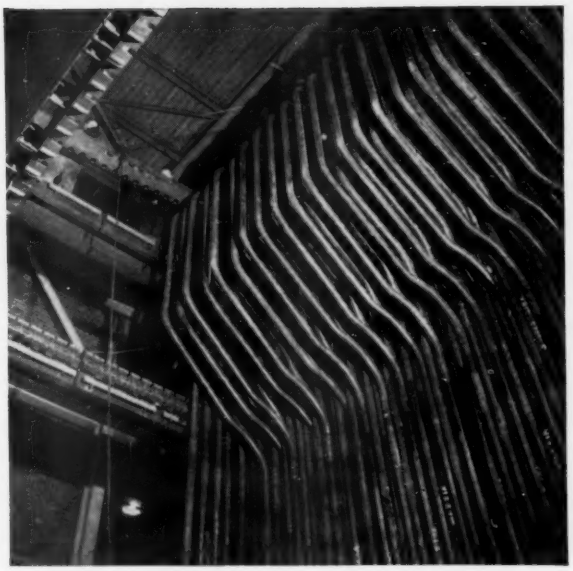
Riley steam generating unit for the City of Painesville, Ohio. 150,000 pounds per hour unit. Design pressure 475 pounds, 750° F. steam temperature. Efficiency 85.0%. Fired by Riley Traveling Grate Spreader Stokers. Consulting Engineer: H. R. Hadlow, Cleveland, Ohio.



MORE POWER FOR PAINESVILLE

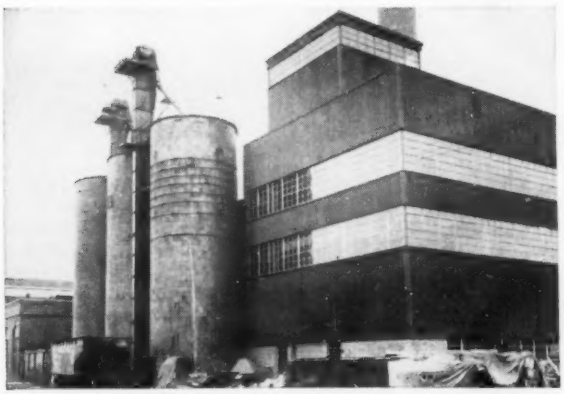


Accurate bends can be easily made, and spring-back calculated before the bending operation when you use ELECTRUNITE Tubes. Reason: uniform ductility.



New boiler house addition at City of Painesville Municipal Light Plant, during erection of Riley steam generating unit. Installers liked the uniform diameter of ELECTRUNITE Tubes.

WITH ELECTRUNITE TUBES



New addition to City of Painesville, Ohio, Municipal Light and Power Plant. Riley Stoker Corp. is furnishing the steam generating unit. Installation supervised by Ralph M. Ray.

More and more consulting engineers are specifying ELECTRUNITE Boiler Tubes. Not only for modernizing older plants, but for new ones as well.

They know that ELECTRUNITE Boiler Tubes are easier to install on the job. They know ELECTRUNITE Tubes have advantages that add up to longer service life in many types of steam-generating and heat-transfer equipment.

Before you decide on your specifications, get all the facts about the ELECTRUNITE Process and ELECTRUNITE Pressure Tubes. Write for: BT-10.

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
221 East 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

Full normalizing makes ELECTRUNITE Boiler Tubes uniformly ductile for smooth bending and roller expanding. It also provides scale-free surface. Tubes are inserted easily into drums and headers.

REPUBLIC STEEL

Republic ELECTRUNITE

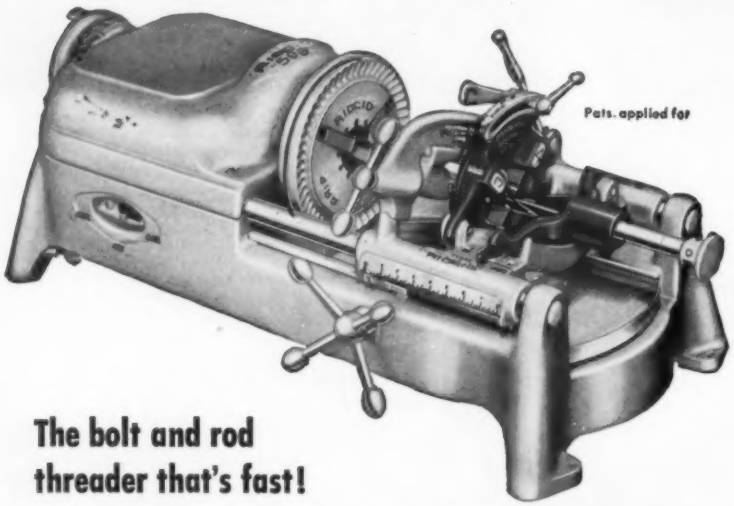
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

ELECTRUNITE — THE ORIGINAL ELECTRIC WELDED BOILER TUBE

For Fast Bolt Threading ... it's the New 500A RIDGID

with new "SPEED-GRIP" CHUCK

New principle . . . not just another hammer chuck!



The bolt and rod threader that's fast!

Capacity ¼" to 2" bolts — pipe, too, ⅛" to 2"

You've got to see it and try it to believe it! Only 2 quick-opening die heads—small head for ¼" to 1" bolts, large head for 1¼" to 2" NC, to 1½" NF—to 2½" in 8N, 12N and 16N . . . easy die change, right or left hand threads, easy adjustment to over or under size. Special dies on request. This 500A threads any length bar to 2½" diam., makes studs with RIDGID Nipple Chuck, cuts off 5/16" to 1" rod. Independent operation of tools. Lots of power. New Speed-Grip Chuck guaranteed to hold rod or pipe securely *forward* or *reverse*—motor action makes it tighter. See it, buy it at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U.S.A.

RIDGID

Work-Saver Pipe Tools

More EQUIPMENT NEWS

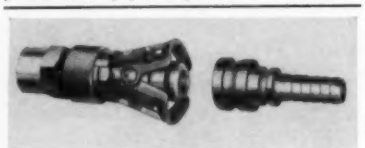
Begins on page 164

Direct Lift Valve

530 • New solenoid direct-lift valve in ⅛ and ¼-in. pipe sizes with high corrosion resistance is constructed of 303 stainless steel with solenoid armature of 416 stainless. Pressures are 5000 psi to 150 F max; 2500 psi to 400 F max. Orifice sizes range from 1/16 to 3/16 in. depending on pressure requirements and coil used. Paper wound or glass-impregnated coils are used depending on temperature range. Coils used on normal pressures are single-wound; higher pressures use double-wound coils with two separate windings, an extremely strong primary winding for initial pull-off and normal winding for holding armature in coil field during operation. Full details in tech bulletin 100.

Atkomatic Valve Co, Indianapolis, Ind.

For more data on these items, use post cards p 173. Identify your request with item number.



Valve Coupling

549 • New valve coupling provides operator complete and safe control of air line at any point between compressor and air-operated device. Nose piece of jaw half has an "O" ring held in a machined groove. When unit is connected, nose piece slides into recess of connection half of coupling. Fluid pressure acts on "O" ring to seal joint tightly, but the two halves are free to swivel without leaking. Couplings are approved by safety authorities and are available in ¼ to ¾-in. sizes with hose or male or female pipe threads. Maximum pressure is 250 psi. Full details available on request.

C B Hunt & Son, Inc, Salem, Ohio

Valves

556 • Complete line of non-plasticized *Type I PVC* needle, plug and globe valves are available in sizes ranging from ⅛ to 2 in. These units supplement *Ampcoflex Type I* and *PVC Type III* sheet, pipe and fabricated structures. *Ampcoflex* sheet is available in thicknesses up to 1 in. in sizes as large as 48x108 in., and pipe is available in IPS sizes up to 6 in. OD.

Atlas Mineral Products Co, Mertztown, Pennsylvania

(*Continued on page* 188)

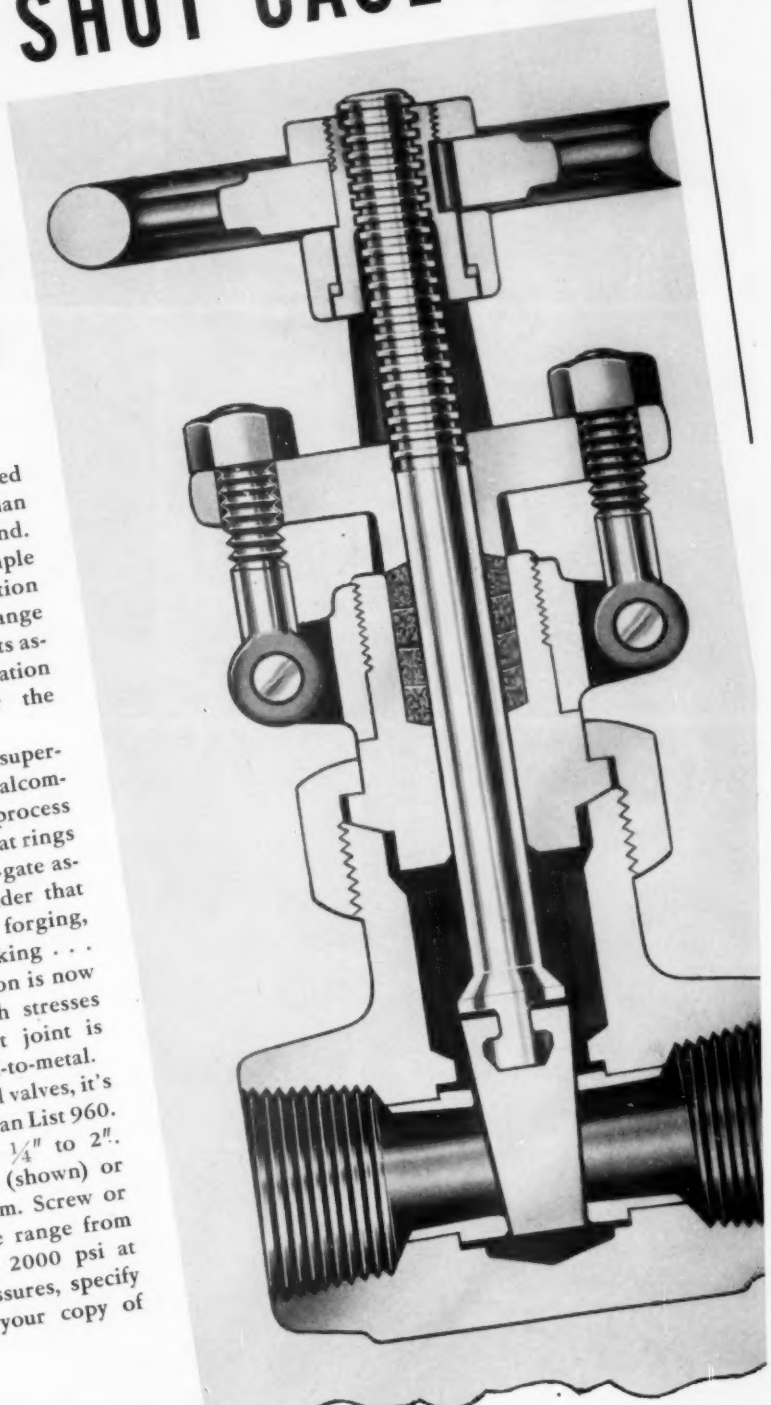
OPEN AND SHUT CASE FOR CHAPMAN LIST 960

Small Forged Steel Gate Valves

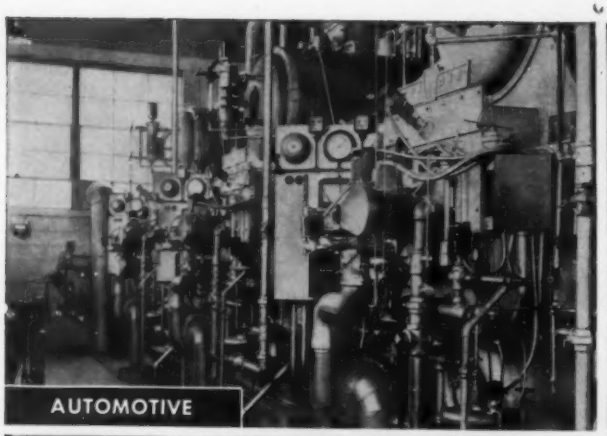
Chapman List 960 is used for more different jobs than any other valve of its kind. And no wonder: its simple and rugged construction means reliability over its wide range . . . super-hardened gate and seats assure tight closure, smooth operation and low maintenance under the toughest conditions.

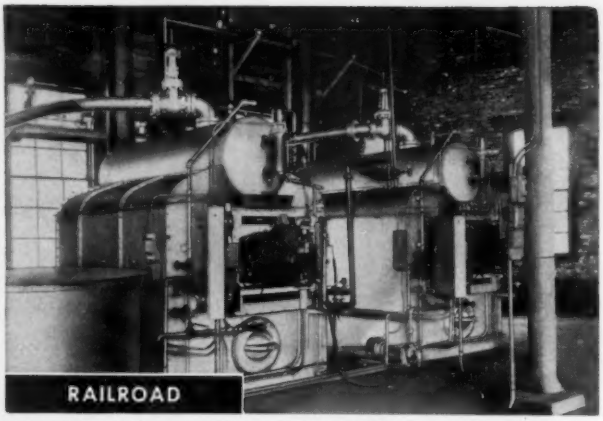
Here's why: gate faces are superhardened to 800 Brinell by Malcomizing, Chapman's exclusive process . . . hardened stainless steel seat rings are replaceable . . . stem-and-gate assembly has a tapered shoulder that seats snug in the bonnet forging, permits full-pressure repacking . . . the stem-and-gate connection is now 50% stronger where high stresses can develop . . . bonnet joint is gasketed or ground metal-to-metal.

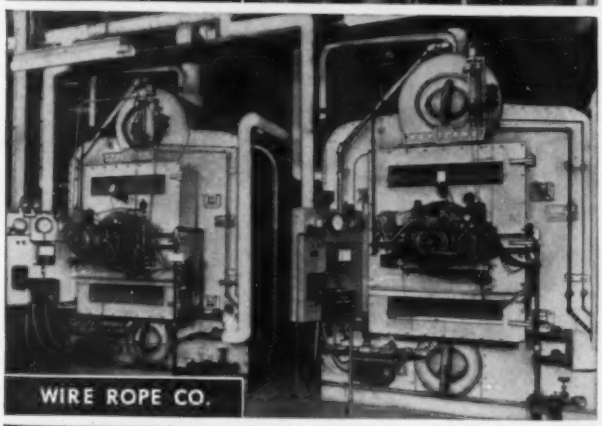
For big savings on small valves, it's a winning case for Chapman List 960. Available in sizes from ¼″ to 2″. Rising stem, with yoke (shown) or inside screw, rising stem. Screw or welding ends. Pressure range from 380 psi at 1000°F to 2000 psi at 100°F. For higher pressures, specify List 990. Write for your copy of Catalog 10 now.

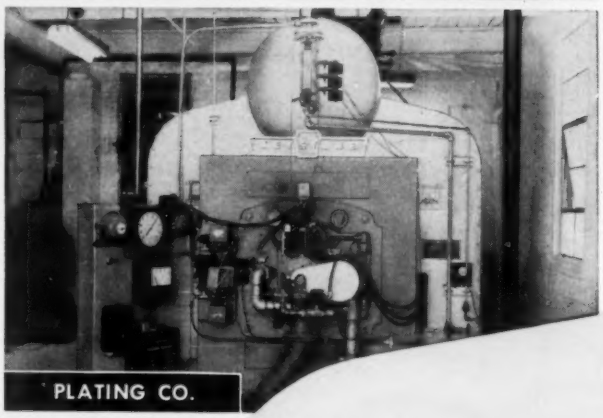


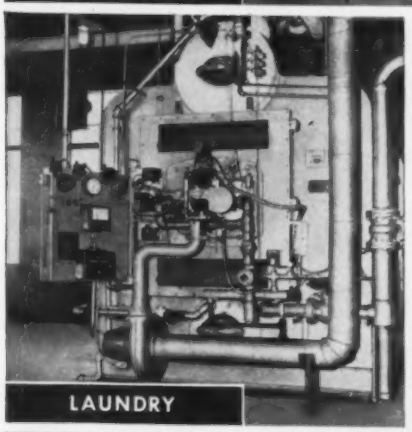
The **CHAPMAN VALVE**
MANUFACTURING COMPANY
Indian Orchard, Mass.


AUTOMOTIVE

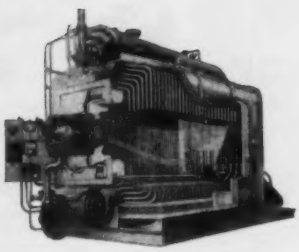

RAILROAD

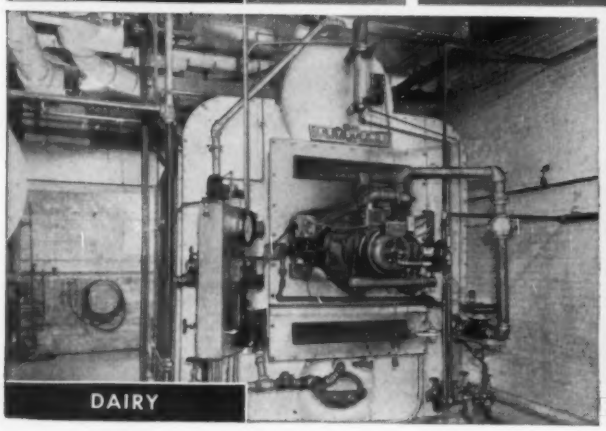

WIRE ROPE CO.

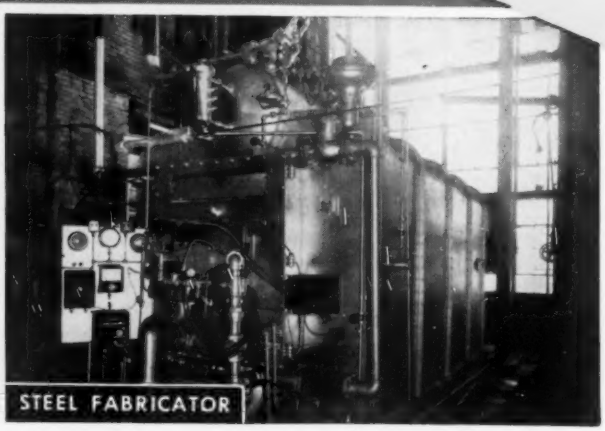

PLATING CO.

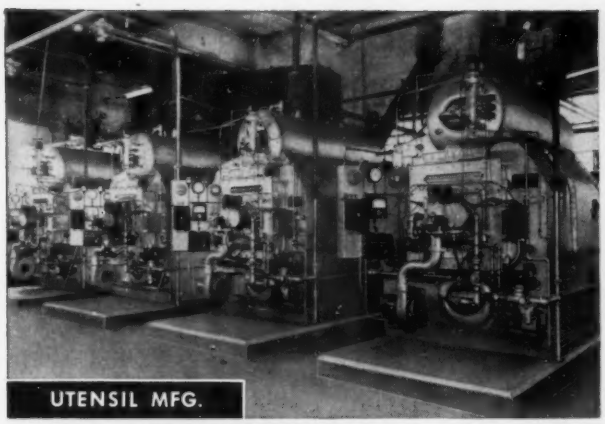

LAUNDRY

You can depend on Erie City for sound engineering~

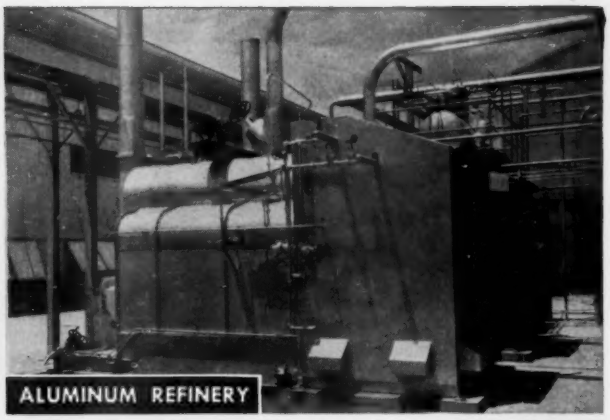



DAIRY


STEEL FABRICATOR



UTENSIL MFG.



ALUMINUM REFINERY

Acceptance

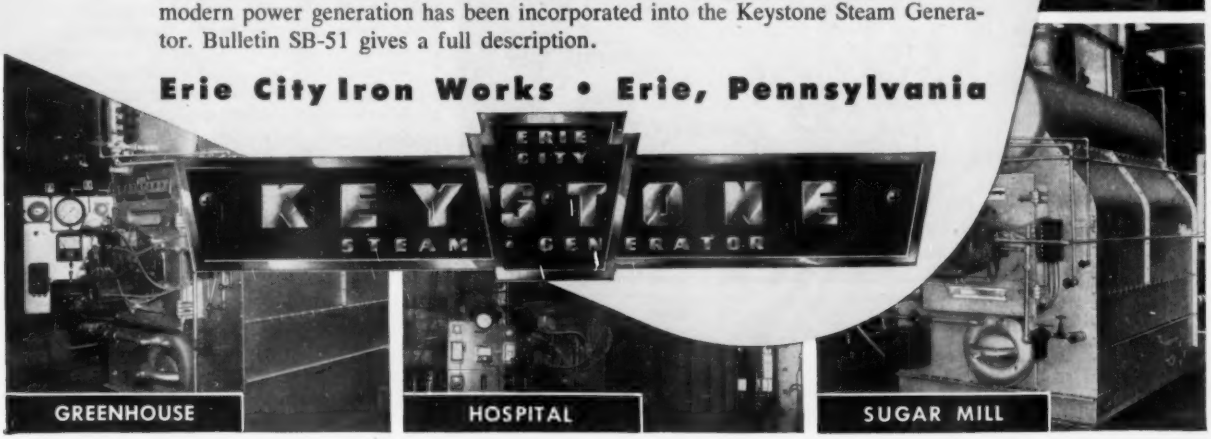
THAT IS EARNED

Erie City Iron Works has hundreds of successful Keystone package water tube boiler installations in all types of industry. True acceptance of any product is the result of successful installations, operating under all types of conditions. Acceptance of the Keystone Steam Generator did not just happen . . . it was earned.

We are proud of our successful installations, operating both indoors and outdoors, with operating pressures ranging from 15 to 600 psi, and producing from 2,500 to 35,000 pounds of steam per hour.

The Keystone is a soundly engineered 2-drum water tube boiler which comes complete with burner, controls and fans all mounted, piped and wired. Add to this the fact that your Keystone is FACTORY FIRE TESTED and you can be assured of a successful and trouble free installation. Every desirable advantage of modern power generation has been incorporated into the Keystone Steam Generator. Bulletin SB-51 gives a full description.

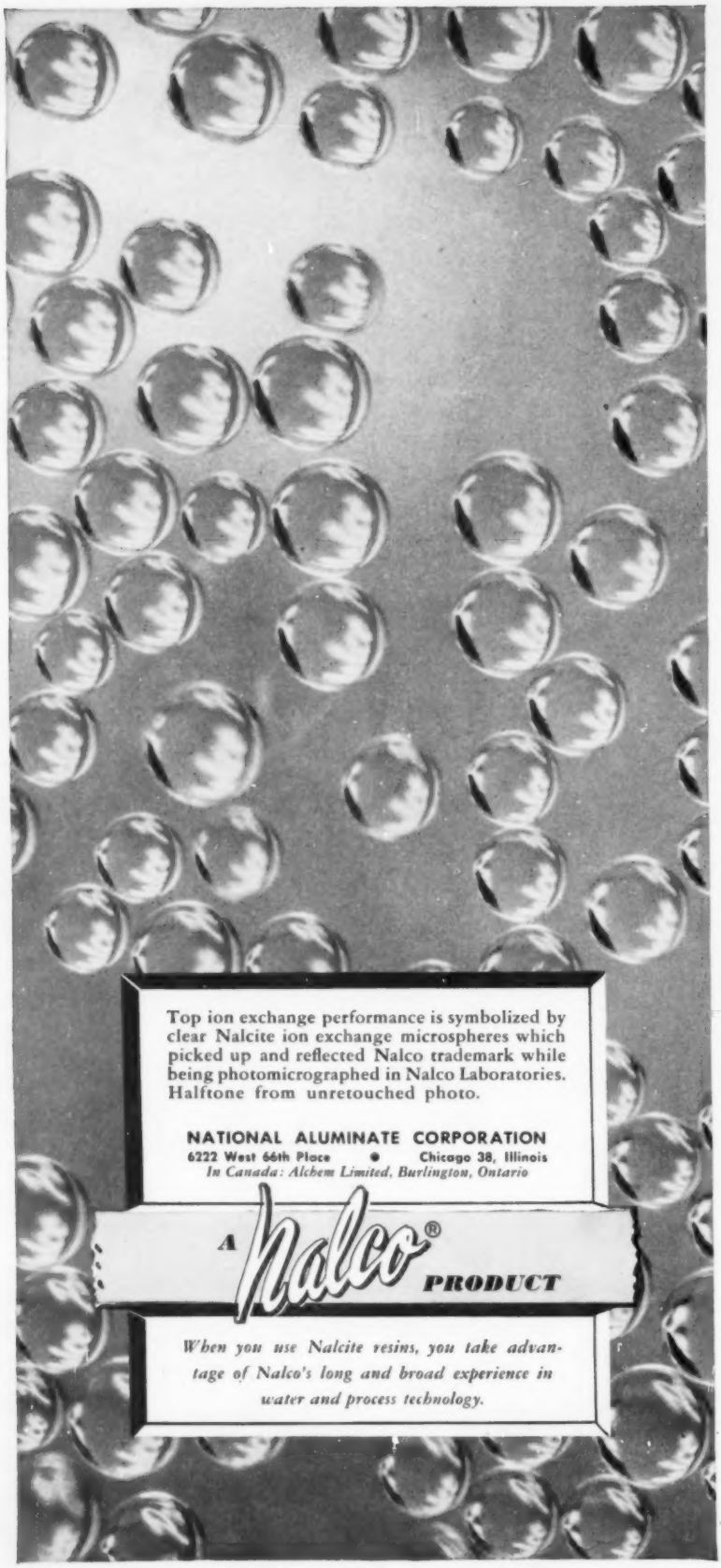
Erie City Iron Works • Erie, Pennsylvania



GREENHOUSE

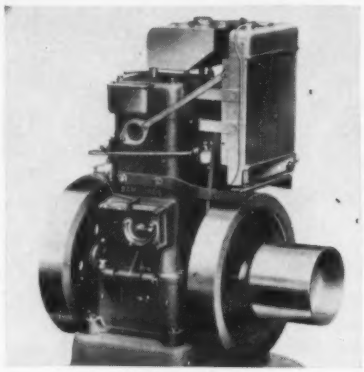
HOSPITAL

SUGAR MILL


Top ion exchange performance is symbolized by clear Nalcite ion exchange microspheres which picked up and reflected Nalco trademark while being photomicrographed in Nalco Laboratories. Halftone from unretouched photo.
NATIONAL ALUMINATE CORPORATION
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario
A Nalco® PRODUCT
When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

More EQUIPMENT NEWS

Begins on page 164



Diesels

551 • Featuring hinged crankcase and detachable governor, single and twin-cylinder slow-speed diesels from 3½ to 16 bhp at 600 to 700 rpm are now available in the United States for the first time in quantity. All seven models in line are of direct-injection type, a feature that provides efficient combustion at all loads and minimum deposit over long periods. Each model starts quickly by hand under all weather conditions, and each can be equipped with auxiliary starting devices. Full details on design and performance available on request to manufacturer.

International Selling Corp, 122 E 42nd St, New York 17, N. Y.

For more data on these items, use post cards p 173. Identify your request with item number.

Diesel Nozzle Cleaning Kit

554 • Standard kit for various types of diesel nozzles contains 58 special-purpose tools. These can be ordered separately or in convenient kit as shown. These tools, according to manufacturer, enable mechanics —even if they have only limited experience —to clean nozzles and injectors competently according to factory-precision standards.

Bacharach Industrial Instrument Co, Pittsburgh 8, Pa.

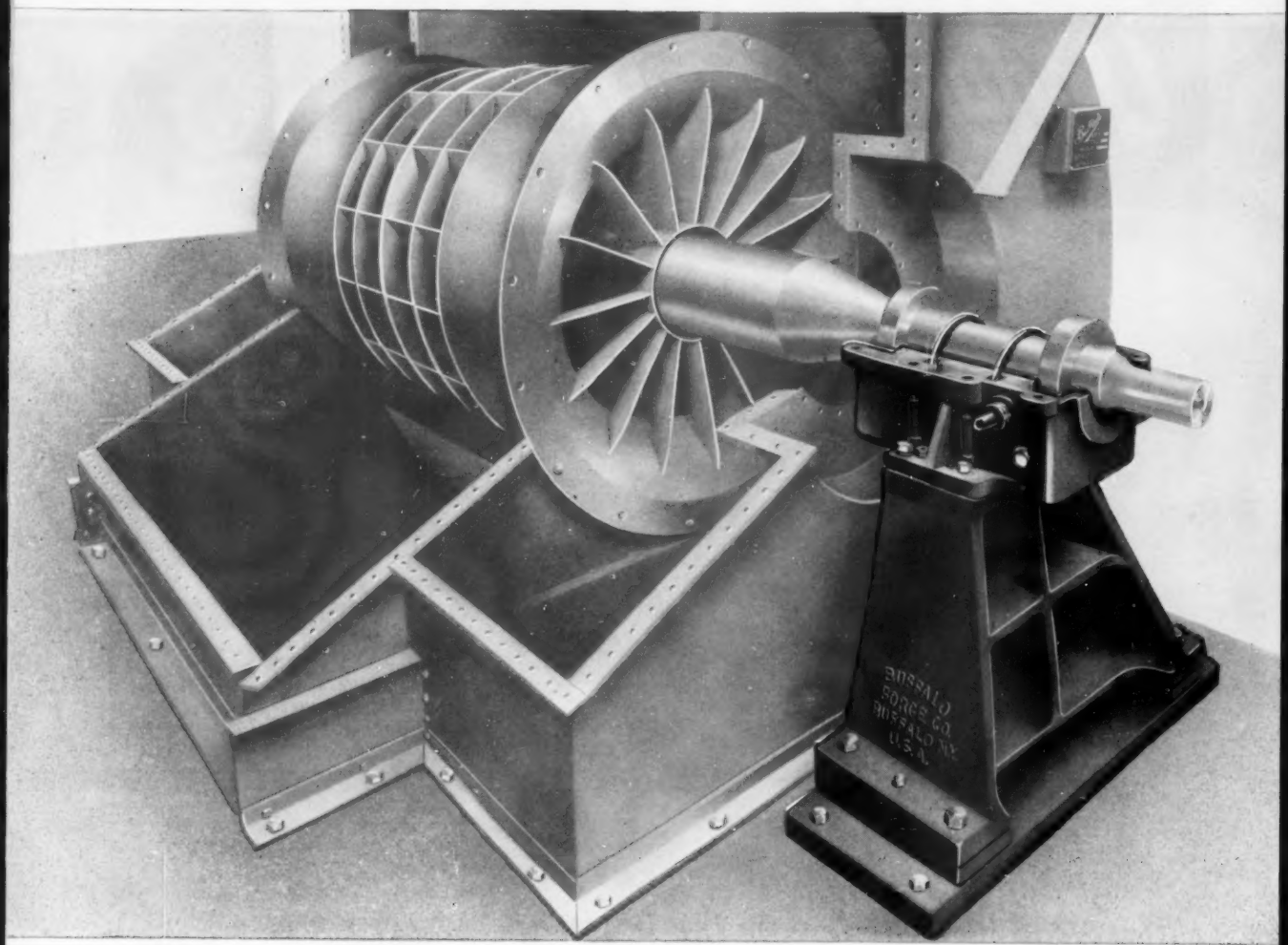
Aluminum Paint

555 • *Thermalite,* a new aluminum paint, is especially useful for coating metal surfaces subjected to heat in the range of 400 to 1000 F. Formulated with special heavy silicone content, it fuses to the surface and will not blister, discolor, flake or burn off. Complete information available on request.

Tropical Paint & Oil Co, Cleveland 2, Ohio

(*Continued on page* 190)

HOW A BEARING HELPS PRODUCE CHEAPER POWER



. . . in "Buffalo" Induced Draft Fans

In the punishing induced draft job, every part of the fan that contributes to longer life and freedom from troubles, is helping to cut your power-production costs.

The "Buffalo" water-cooled self-aligning bearing is built to stand heat and continuous, extremely heavy load. The sole plate, pedestal and bearing housing are oversize and completely rigid. Both bearing liner halves are water-cooled. The oil reservoir is extra-large. The self-aligning water-cooled liners are easily removable for servicing operations, without disturbing pedestal, shaft or rotor.

In fact, all parts of "Buffalo" Draft Fans are of equally sturdy, accessible construction — housings, shafts and rotors. This construction is not cheap; it is in line with the "Buffalo" "Q" Factor* which in installation after installation has saved users money through added years of performance on the job. For further information — write today for Bulletin 3750.

** The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.*

"Buffalo"

BUFFALO FORGE COMPANY

488 BROADWAY BUFFALO, N. Y.

Publishers of "Fan Engineering" Handbook

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

WORKS WELL *Under Pressure*

This True Ball Joint Makes the Difference

Dart malleable iron unions, sizes ⅛″ to 2″ are recommended for 300 lbs. working steam pressure; sizes 2½″ to 4″ for 250 lbs. working steam pressure at temperatures not over 500° F. Darts give a snug, drop-tight fit easily without excessive wrenching — and you can use them over and over again.

QUICK FACTS

- *Leakproof* because precision-machined to a true ball joint and spherically ground.
- Bronze alloy seats are extra wide, resist pitting and corrosion.
- Shoulders are heavy — can take rough treatment.
- Nut and Body are practically indestructible . . . of air-refined, high test malleable iron.
- Take the pressure off *yourself* — tell your supplier you want *Darts!*

DART

UNIONS

DART UNION COMPANY • PROVIDENCE 5, RHODE ISLAND

The Fairbanks Co. — Distributors: Boston • New York • Pittsburgh • Rome, Ga.

More EQUIPMENT NEWS

Begins on page 164

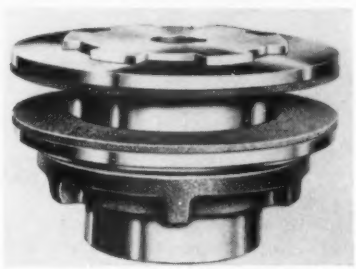
Unit-supported Bus

520 • New unit-supported bus of isolated-phase design withstands high short-circuit currents of modern systems and has margin for future system growth. This bus is ordinarily used for direct connection of generators and main power transformers in a unit generation system. Weighing 13½% less than present typical 3-phase sections and having single insulator supports, equipment allows easier installation and maintenance than did previous designs.

Other features for simplifying maintenance include smaller covers with less gasketing area providing complete accessibility to insulator supports and connections, simplified hardware on covers for easier access to bus, a ground clip that slides back for testing without disassembly and completely welded end bells for greater strength. The new bus is available in lengths of 3-phase sections up to 16 ft and ratings up to 10,000 a, 14.4 to 34.5 kv.

General Electric Co, Schenectady 5, New York

For more data on these items, use post cards p 173. Identify your request with item number.



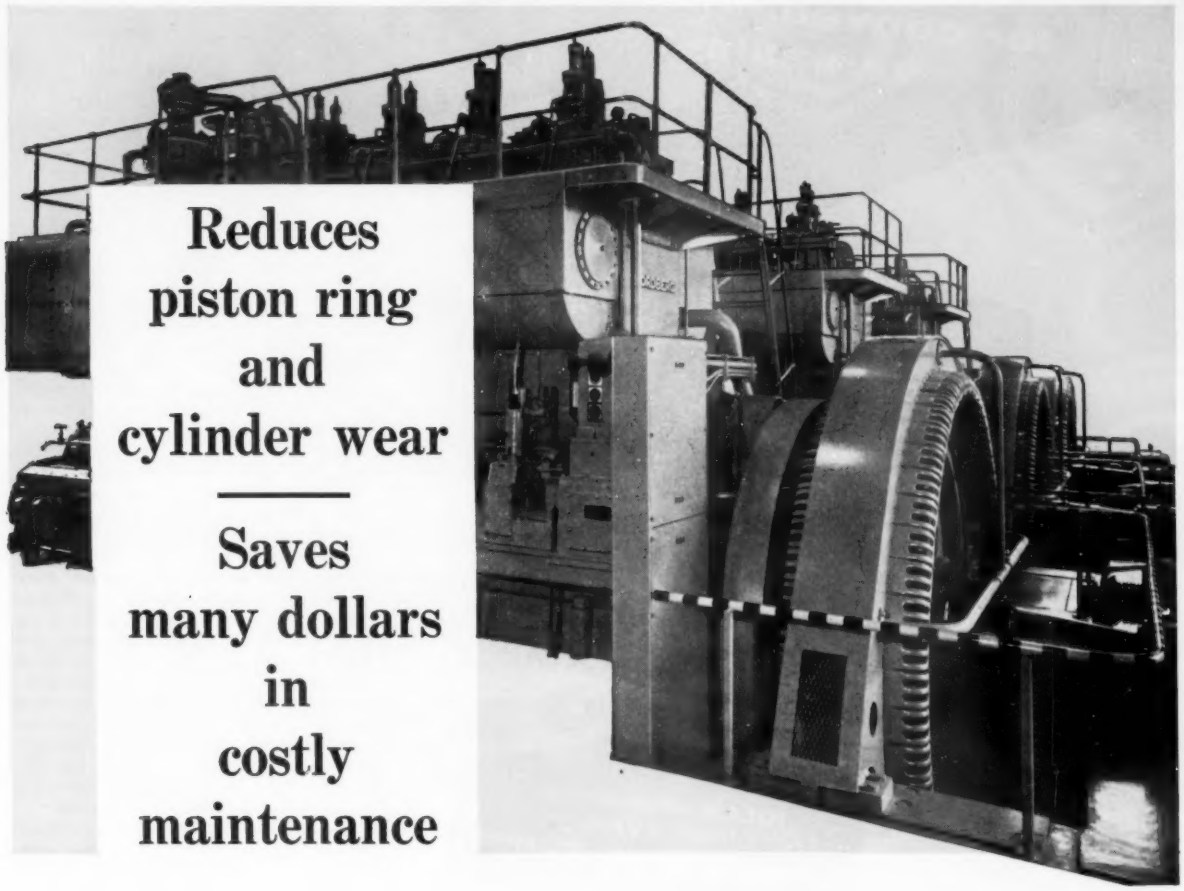
Clutches Check Overloads

526 • New line of compact, adjustable torque-limiting overload protection devices for wide variety of machine drives is now available. These slip-type friction clutch devices feature powdered metal bushing on which such drive components as chain sprockets, V-belt pulleys or gears can be mounted. Eleven standard models provide maximum torque capacities from 20 to 620 ft-lb. Typical applications include drives for conveyors, materials handling equipment, agricultural equipment, automated machine tools and related types of drives where overload protection is required. Full details available on request.

Morse Chain Co, 7601 Central Ave, Detroit 10, Michigan

(*Continued on page* 192)

Shell Rotella Oil



Reduces piston ring and cylinder wear

Saves many dollars in costly maintenance

These dual-fuel engines in the Municipal Power Plant at Houma, Louisiana, supply dependable, low-cost electric power to the entire city. Shell Rotella Oil is the cylinder lubricant.

Here's just one of the many diesel power plants that depend on SHELL ROTELLA OIL for reduced wear of engine parts . . . lower maintenance cost.

The anti-corrosive action in Shell Rotella Oil combats the major cause of engine wear . . . cylinder and piston ring wear caused by acid action from the by-products of incomplete combustion and condensation.

Tougher lubricating film in Shell Rotella Oil gives cylinders and rings greater protection . . . minimizes wear. Its effective detergent-dispersant action prevents harmful deposits.

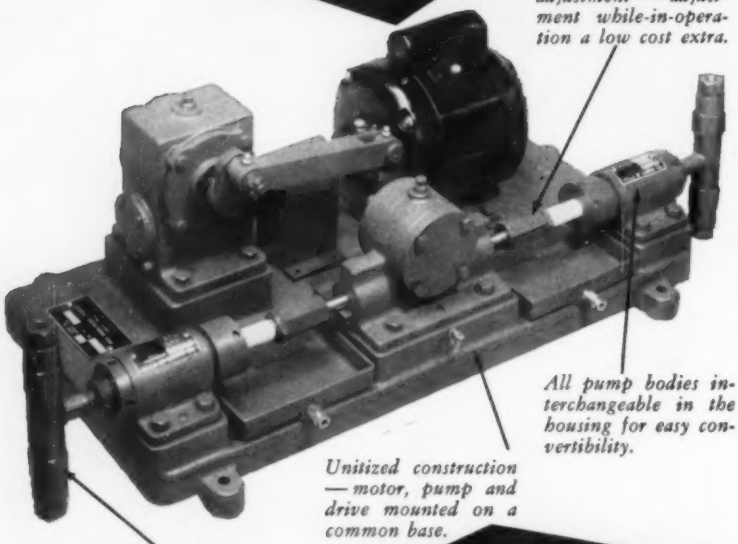
Write for technical information. See for yourself how Shell Rotella Oil can help reduce your engine maintenance costs.

SHELL OIL COMPANY

50 WEST 50TH STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL®

Can your proportioning pumps match this for convenience and versatility?


Easy, precise stroke adjustment — adjustment while-in-operation a low cost extra.
All pump bodies interchangeable in the housing for easy convertibility.
Unitized construction — motor, pump and drive mounted on a common base.
Separate, interchangeable external check valves for easy dismantling or replacement.

HILLS-McCANNA "U" TYPE PROPORTIONING PUMPS

Hills-McCanna "U" Type Proportioning pumps combine precision operation with high standards of convenience and versatility not ordinarily associated with pumps of this type. The "U" pump is easy to install and can be converted quickly and economically for changing service requirements.

If you must continuously meter or proportion small volume flows with great accuracy, it will pay you to consider a Hills-McCanna "U" Type Pump. Capacities range from 0.10 to 24 gph per feed, 1, 2, 3 and 4 feed units are available.

Write for Catalog UP-54. HILLS-McCANNA CO., 2369 W. Nelson St., Chicago 18, Ill.

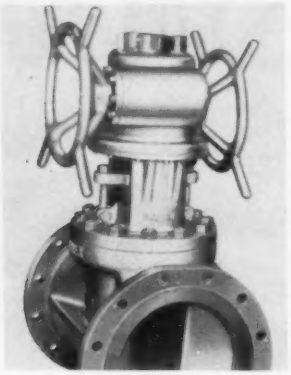
HILLS-McCANNA

metering and proportioning pumps

Also Manufacturers of:
SAUNDERS TYPE DIAPHRAGM VALVES
FORCE FEED LUBRICATORS • MAGNESIUM SAND ALLOY CASTINGS

More EQUIPMENT NEWS

Begins on page 164



Plug Valves

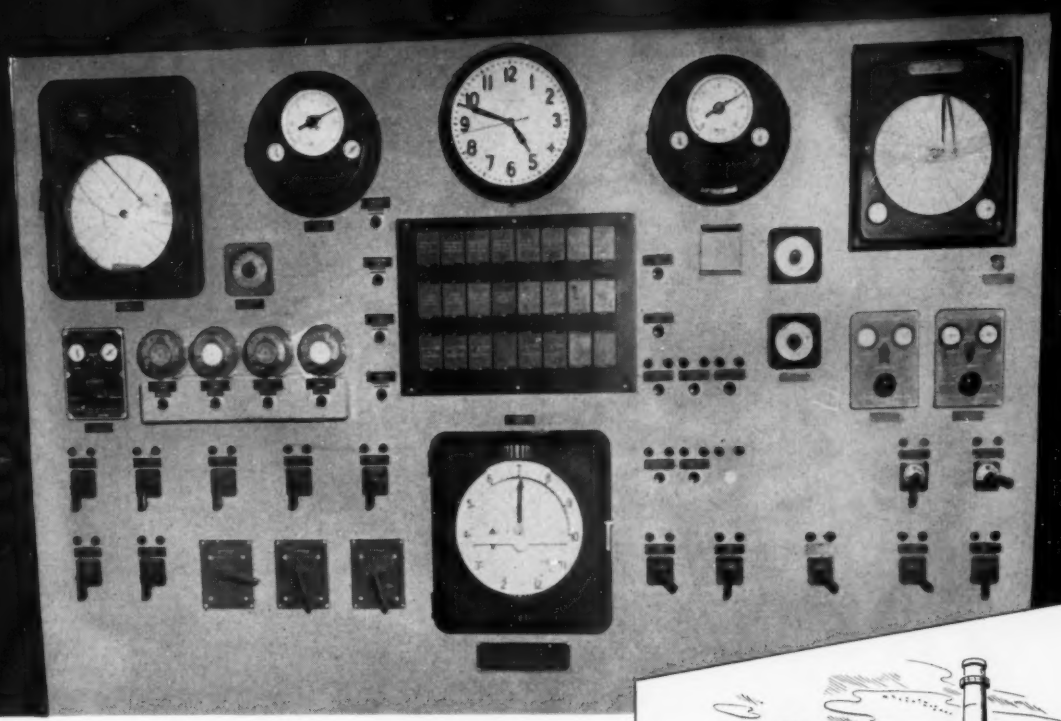
533 • Two new balanced-type plug valves, 10 and 12 in., are available in ASA 150# and 300# classes in carbon steel as well as other materials designed to meet any service condition. Chain wheel attachments for overhead operation are available on both models. Intended for refinery and general service involving high as well as low temperatures, these valves are gland packed. Packings can be changed under pressure while line is on stream.

Extremely versatile, these units can be operated with or without lubricant. They are equipped with lubrication fittings through which an ordinary medium grade of grease may be applied to packing and bearing surfaces. Valves are so designed that lubricant fills balance chambers first; grease will not enter line unless excessive amount is used. These valves will operate effectively with lubricator hole plugged. Descriptive literature available on request. **Hamer Oil Tool Co, 2919 Gardenia Ave, Long Beach 6, California**

For more data on these items, use post cards p 173. Identify your request with item number.

Ring Rheostat

524 • New 300-w ring rheostat is designed for use in ac and dc circuits where smooth, accurate control is essential. It is particularly useful where "stepped" rheostats do not furnish sufficiently close adjustment. Typical applications include: generator and motor field, electron tube, battery charging, oven and lamp dimming control. Dimensions: 6-in. dia. back-of-panel depth only



Atlantic City Electric Company selects PERMUTIT WATER CONDITIONING with *centralized, automatic control*

Greenwich Station. Normal steam capacity: 460,000 lb per hr. Engineered and constructed by Burns and Roe, Inc., New York City.

To FILL *changing* demand for 100% makeup with highest purity feedwater requires the best of equipment and a degree of efficiency obtainable only with modern automatic control.

At the Greenwich Station, instrumentation — centralized in Permutit cubicles — provides this control. The water-treatment plant supplies makeup that meets requirements for two 650 psig boilers operating under *wide ranges* in load . . . for steam output and turbo-generator exhaust must also fill the changing process-steam needs of a very large, nearby chemical plant.

TREATMENT METHODS SPECIFIED

Consulting engineers investigated several plans to determine the most efficient and economical means of making Delaware River water satisfactory for two 230,000 lb per hr boilers. Final decision was to treat the water with *Permutit equipment:* coagulation, silica reduction, filtration, hydrogen-sodium-zeolite softening, degasification . . . with provision for demineralization if required.

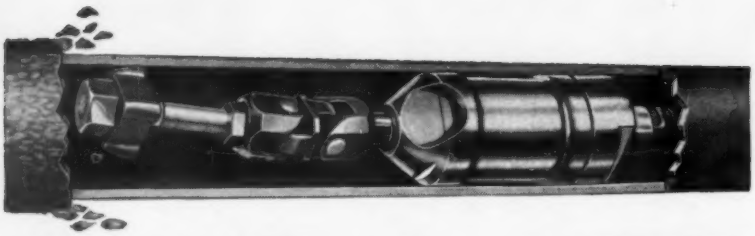
REQUIREMENTS FOR COMPLETE CONTROL

Mounted on the Permutit central control board are flow controllers and loss of head gauges for each filter; flow recorders, level indicators, alarms, timing devices, etc. A pH indicator assures proper blending of the sodium and hydrogen-zeolite softened waters. After setting flow rates, timing elements, etc., this entire Permutit water-treatment system operates *automatically!*

Find out how Permutit can solve your water problems. Write to THE PERMUTIT COMPANY, Dept. P-5, 330 West 42nd Street, New York 36, N. Y. or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

PERMUTIT®
Registered Trade Mark

ION EXCHANGE AND WATER CONDITIONING
HEADQUARTERS FOR OVER 40 YEARS



ROTOJET®

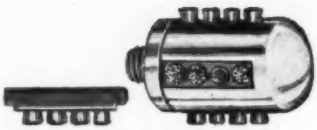
Cleans Fire Tubes ▸▸▸▸▸▸ FAST ▸▸▸▸▸▸▸ INSIDE and OUTSIDE

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

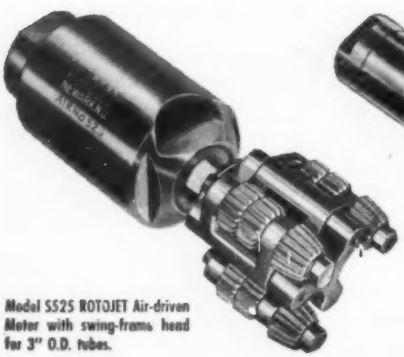
Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.



Model S525 ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model S505 ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

ELLIOTT COMPANY-ROTO DIVISION

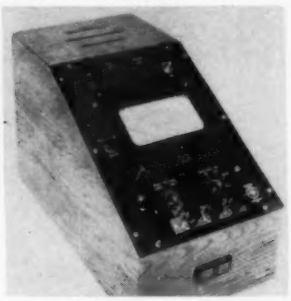
153 Sussex Avenue Newark 1, N. J.

More EQUIPMENT NEWS

Begins on page 164

2 3/16 in. Resistance values range from 1 to 2500 ohms; 300-w rating is based on 300 C rise. Tandem mounting, tapered windings and other non-standard features available on special order.

Ward Leonard Electric Co, Mount Vernon, New York



Megohmeter

523 • New megohmeter is designed for high-speed testing of transformer winding, motor windings, cables, capacitors and all other types of insulation leakage in accordance with ASTM spec D-257-52T. Instrument is bench-type, entirely self-contained in cabinet with sloping operating panel. Simple operation permits use in production testing and inspection. Available in three models of varying ranges, and test voltages, Type L megohmeter can be extended in range on the job by means of external power supplies. Full details available on request from manufacturer.

Industrial Instruments, Inc, 89 Commerce Rd, Cedar Grove, N. J.

For more data on these items, use post cards p 173. Identify your request with item number.

Ac Voltmeter

537 • Advanced ac voltmeter features both scale expansion and recording over 100 to 500 v range. Instrument covers range in 39 easy-to-read 10-v steps, full scale. True rms readings are obtainable with accuracies better than ±0.25% of input voltage. Frequency response is uniform between 50 and 2000 cps, eliminates need for delicate or specially built laboratory voltmeters to measure ac voltages accurately. Full details available in bulletin 101.

Beckman Instruments, Inc, 220 Pasadena Ave, S Pasadena, Calif.

(*Continued on page* 196)

ANCHOR HEAT HOLD TAPE

. . . Is Known For Its COMPLETE INSULATION VALUE On All Types of Pipes

Anchor Heat Hold Tape is a highly flexible asbestos pipe insulation, widely used for its many advantages and saving features. It is composed of asbestos braided over a felted asbestos core.

The tube, forming a sheath or cover, is unique; woven so it can be wrapped closely, tightly and smoothly on all pipes without wrinkling. This is important in the prevention of radiation of heat. The core is fiberized asbestos, allowing greater uniformity and more complete insulation than other methods of construction.

Anchor Heat Hold Tape is for pipe insulation on locomotives, steamships and power plants where vibration is present. Also, on pipe insulation where the lines must be dismantled at intervals for cleaning or repairing.

Full details on Anchor Heat Hold Tape are contained in a new color booklet which we shall gladly send upon request. Write today for your copy.

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THE ANCHOR PACKING COMPANY

GENERAL OFFICES: PHILADELPHIA, PA.
FACTORIES: MANHEIM, PA. ELKHART, IND. MONTREAL, CAN.

FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

NEWS FROM Femco

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NOW! Brilliant new low-cost communication networks. You talk from control points to plant and between plant operations over as many mike-speaker stations as you need!

FIXED-POINT, WIRED COMMUNICATION

Users save time, money and energy. Production is increased, safety promoted and morale and efficiency improved.

EASY TO INSTALL!

Other Femco products of merit include:

PAGEPHONES

You page and converse anywhere in business or industry.

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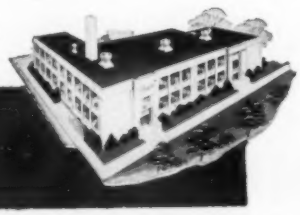
Use carrier current over your existing power lines.

Ask for YOUR Femco Data Kit

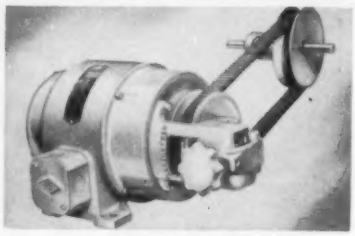


FARMERS ENGINEERING
AND MANUFACTURING CO.
IRWIN, PENNSYLVANIA

Specialists in Electronic Communication and Control

More EQUIPMENT NEWS

Begins on page 164

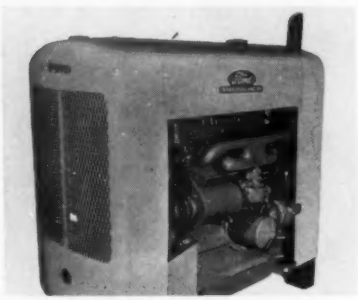


Motor Design

514 • New motor design features special adapter end bell for direct mounting of *Flexi-speed* drives. This eliminates need for separate foot-mounted index support and permits mounting of both motor and drive as single, compact and well-aligned unit. Motors already adapted to this system are available in ½ and ¾ hp, 1800 or 1200 rpm input speeds with drive ratio of either 8:1 or 6:1. One-hp unit with 1800 rpm input speed has drive ratio of 7:1 or 6:1. Full details available from manufacturer.

Reuland Electric Co, Alhambra, Calif.

For more data on these items, use post cards p 173. Identify your request with item number.



Industrial Engine

540 • New "172" industrial engine offers mightiest concentration of power per cu in. of displacement in its size and weight class according to manufacturer. With 172-cu in. displacement, new four-cylinder power plant delivers 61 bhp at 2800 rpm. Large bore, short stroke and low friction design permit more economical operation and lengthen engine life. Full details on construction and performance available on request to manufacturer.

Ford Division, Ford Motor Co, Dearborn, Michigan

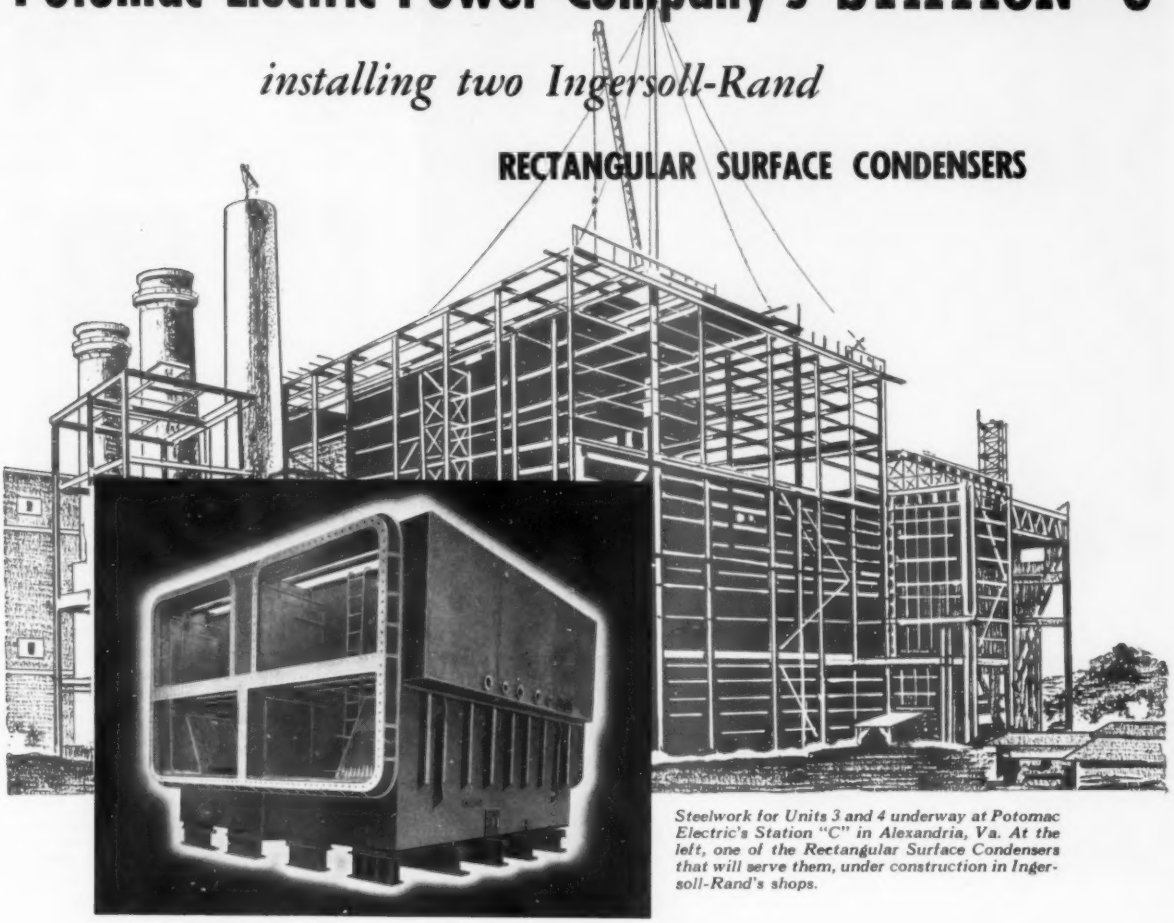
Precision Flow Gun

529 • New precision flow gun combines all features of two models formerly carried in Binks line. New gun provides increased efficiency in flowing sealing compounds

Potomac Electric Power Company's STATION "C"

installing two Ingersoll-Rand

RECTANGULAR SURFACE CONDENSERS



Steelwork for Units 3 and 4 underway at Potomac Electric's Station "C" in Alexandria, Va. At the left, one of the Rectangular Surface Condensers that will serve them, under construction in Ingersoll-Rand's shops.

I-R 70,000 sq. ft. surface condensers to serve 100,000 kw turbines for units 3 and 4

TO meet the ever-growing load demands of the Nation's Capital area, Potomac Electric is adding 200,000 kw to the capability of its Station "C" in Alexandria. Stone & Webster Engineering Corp. are the designers and constructors collaborating with the utility on this project.

Two Ingersoll-Rand Rectangular Surface Condensers have been selected to serve these latest 100,000 kw units. Each condenser will have an effective area of 70,000 square feet and will be served by two Ingersoll-Rand vertical circulating pumps that deliver a total of 60,000 gpm.

Other Ingersoll-Rand equipment at this station includes the condensate pumps, condensate booster pumps and compressors which supply station air.

In this installation, as in many others, the Ingersoll-Rand Rectangular design made the most effective use of the *rectangular* space available beneath the turbine. And through a perfected system of complete shop erection, where all parts are flanged and match-marked, no structural field welding is required. Installation is as simple as possible, considering the size of the equipment. For the complete story on I-R equipment for the power industry, call your nearest Ingersoll-Rand branch office.

Ingersoll-Rand

979-4 11 Broadway, New York 4, N. Y.

PUMPS • COMPRESSORS • VACUUM EQUIPMENT • TURBO BLOWERS • ROCK DRILLS • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS

No mud
No dust

NO CLEANUP TIME

*with G-B Snap*On Pipe Insulation!*

Insulating pipes is no longer a messy job that ruins the appearance of the plant — not when you use G-B Snap-On pipe insulation! This new one-piece pipe insulation of molded fine glass fibers is absolutely dustfree —won't crumble or flake when dry, won't get gummy or muddy when wet. For these reasons, it can be applied during regular working hours.

Because it is so clean to handle, this new pipe insulation involves almost NO CLEANUP TIME — one of the big reasons why users report application savings up to 50%. This unusual cleanliness feature also makes it very popular in food, chemical and other plants that cannot afford to run the risk of product contamination.

Other properties are equally unusual and pleasing. G-B Snap-On pipe insulation is exceptional in thermal efficiency . . . 4 to 10 times lighter than any other . . . easy to finish . . . easy to cut with a knife . . . fire-resistant . . . rotproof . . . won't absorb moisture. But don't take our word for it — write today for samples and make your own tests. You'll find that in every respect G-B Snap-On pipe insulation is the first all new pipe insulation in 60 years!

*Trademark Reg.

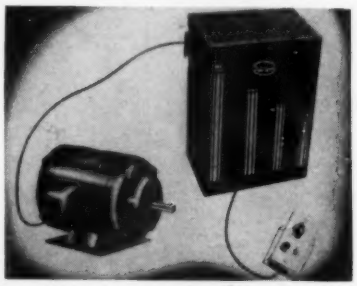
gb **GUSTIN-BACON MFG. CO.**
248 W. 10th ST., KANSAS CITY, MO.
New York • Chicago • Philadelphia • San Francisco • Los Angeles
Houston • Tulsa • Dallas • Detroit • St. Louis

More EQUIPMENT NEWS

Begins on page 164

such as asphalt, rubber cement and similar heavy materials. Sixteen nozzles with orifices of various sizes and shapes are available. Manufacturer also offers a special model for use in applying abrasive materials used in ceramic field. Full details available.

Binks Mfg Co, 3122 Carroll Ave, Chicago 12, Illinois

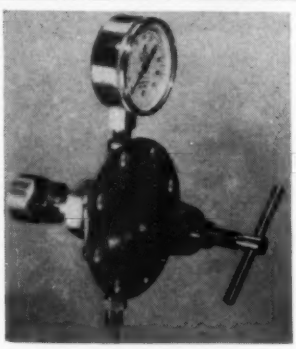


Motor Control Systems

515 • Completely redesigned line of electronic variable-speed motor-control systems from 1/5 to 3 hp models now make use of special terminal-block transformer construction, special cabinet design and critical component plug-in assemblies. Controlled acceleration on many models allows use in applications of high inertia loads without placing excessive torque load on materials in critical processes. Specialized designs are available to meet particular customer requirements. Complete literature on stock models is available from manufacturer.

Brown-Brockmeyer Co, Dayton, Ohio

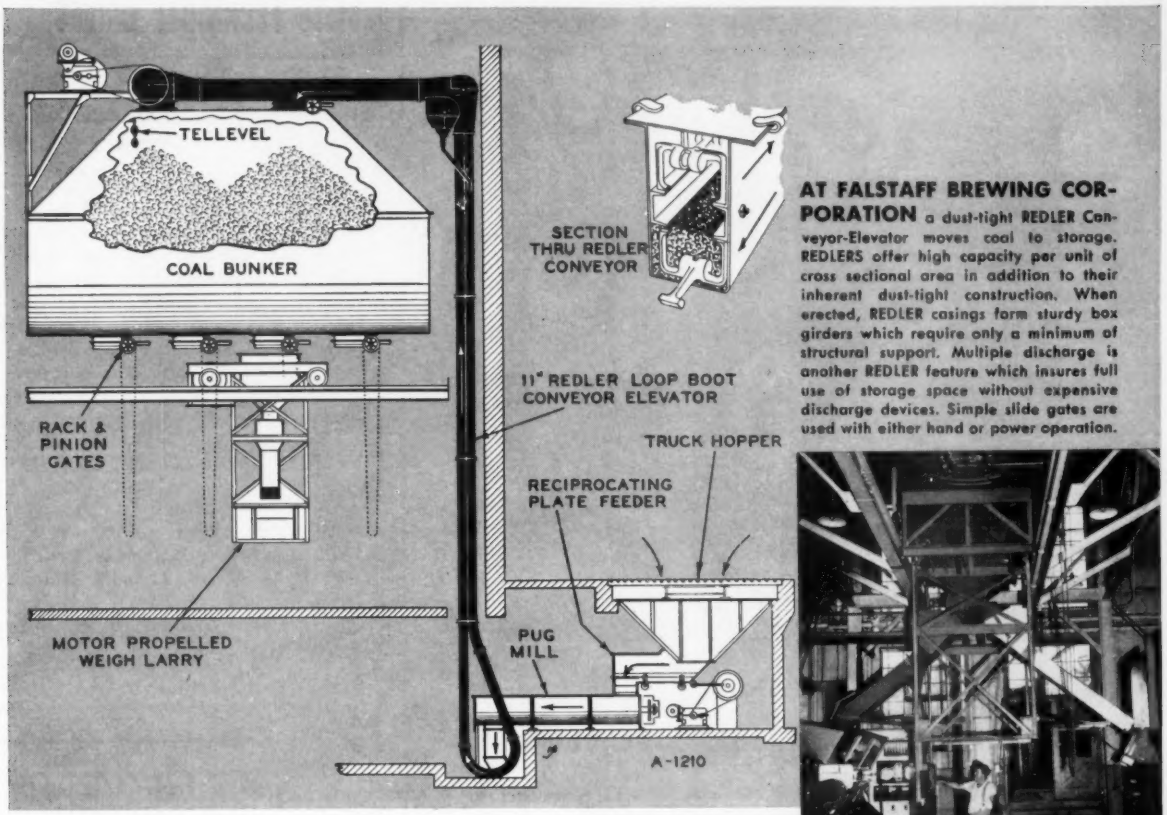
For more data on these items, use post cards p 173. Identify your request with item number.



Pipeline Regulators

531 • New 8900 series of regulators is designed for use with gas supplied by pipeline systems using comparatively low pressures. These new oxygen cutting and welding regulators afford greater flow capacities with improved regulation and lower static increment. Regardless of fluctuation in line pressure, these units accurately maintain steady gas pressure and thereby eliminate need for frequent adjustment. They are of the inverse-type design and feature novel seating arrangement requiring no nozzle. Complete data available in Catalog ADC705.

Air Reduction Sales Co, 60 E 42nd St, New York 17, N.Y.



AT FALSTAFF BREWING CORPORATION a dust-tight REDLER Conveyor-Elevator moves coal to storage. REDLERS offer high capacity per unit of cross sectional area in addition to their inherent dust-tight construction. When erected, REDLER casings form sturdy box girders which require only a minimum of structural support. Multiple discharge is another REDLER feature which insures full use of storage space without expensive discharge devices. Simple slide gates are used with either hand or power operation.

Good Housekeeping Starts with Dust-Free Coal Delivery

From boiler-room to bottling-line, cleanliness is the keynote of Falstaff's brewing process!

A key to the spotless maintenance in this St. Louis plant is a compact REDLER Coal Conveying System. Designed for automatic operation, this completely *sealed* system moves coal from track hopper to stoker hoppers and never gives dust or dirt a chance to escape along the way. In addition to its dirt-free operation, the REDLER System provides important savings in man power. These features, plus meeting of limited space requirements, made a compact REDLER the logical choice on all counts.

If clean handling — of coal or any commodity — in limited space, at low cost per ton is important to you, a REDLER Conveying System will meet your complete requirements. Our engineering department will welcome the opportunity to survey your problem. Use the coupon today.

STEPHENS-ADAMSON MFG. CO.

5 Ridgeway Avenue, Aurora, Illinois
Los Angeles, Calif., Belleville, Ontario

Engineering Division	Specialists in the design and manufacture of all types of bulk materials conveying systems.
Standard Products Division	A complete line of conveyor accessories including centrifugal loaders—car pullers—bin level controls—etc.
SealMaster Division	A complete line of industrial ball bearing units available in both standard and special housings.

Stephens-Adamson Mfg. Co.
5 Ridgeway Avenue, Aurora, Illinois

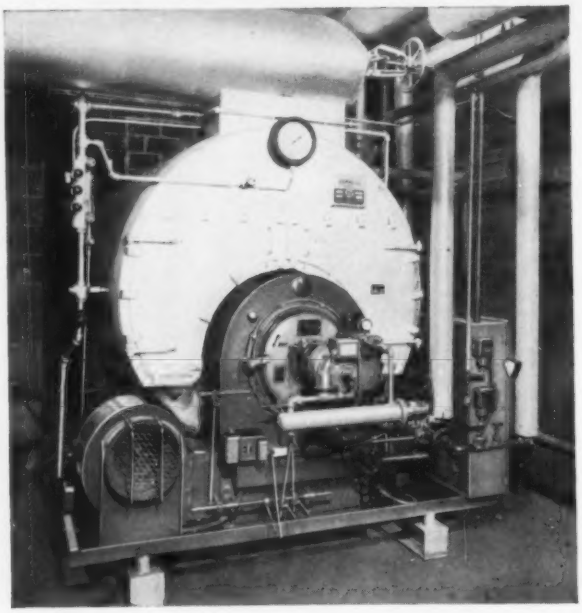
Please send me your Bulletin No. 140 on REDLER Conveyors.

Name_____

Company_____

Address_____

City_____ Zone____ State_____



RAY Forced Draft 'Packaged' Burner Selected for Michigan School

HEMLOCK, MICHIGAN—The architectural and consulting engineer firm, the Warren S. Holmes Co., Lansing, Michigan, selected the RAY Forced Draft 'Packaged' Oil Burner for installation in Hemlock Elementary School.

Initial combustion tests of the installation showed 13% CO_2 on high fire and 12% CO_2 on low fire with a stack temperature of less than 100° F. above the steam temperature according to the oil burner contractor, the Joseph M. Day Company of Saginaw, Michigan.

The Hemlock School installation was one of the first local applications of the Ray Oil Burner Co.'s new 'packaged' units which contain all the combustion components necessary for fully automatic operation on oil, gas or combination gas-oil factory wired, piped and mounted on a structural steel base, ready for installation on the boiler front.

Send for Catalog Unit Y

RAY OIL BURNER CO.
Since 1872
1301 San Jose Avenue • San Francisco 12, California
Atlantic Seaboard Div. • 629 Grove St., Jersey City 2, N.J.
DISTRIBUTORS IN ALL PRINCIPAL CITIES OF THE WORLD

SEE THE RAY FD COMBINATION UNIT AT THE OHI EXPOSITION IN PHILADELPHIA

More TECHNICAL BRIEFS

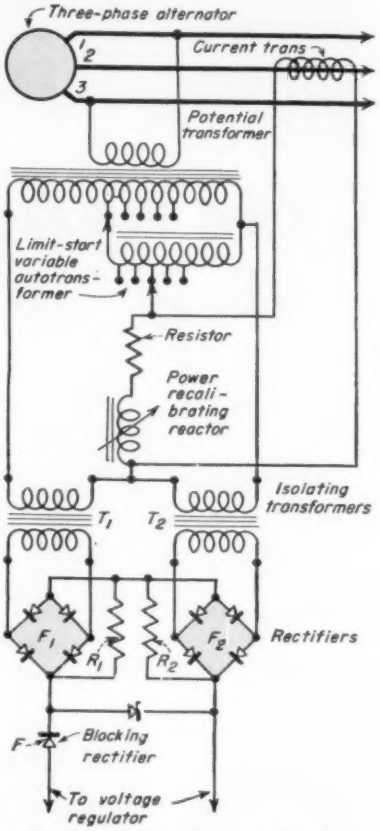
Begins on page 160

trol, power-shovel control and a host of other systems, the reversability of rotating regulators reduces equipment and simplifies system.

Rotating regulators have enjoyed success in the past; their future appears to be bright. There will be, of course, some fields in which other types of regulators will replace them. We can be sure that increasing numbers of magnetic and electronic preamplifiers will find use with rotating regulators.

Because of its simplicity, its reversibility and its ability to absorb power in applications where medium to large output powers are required, the rotating regulator will remain attractive. *AIEE conference paper, available from the author.*

Underexcited Reactive-Ampere Limit for Modern Amplidyne Voltage Regulators. *By A S Rubenstein and M Temoshok, both of the General Electric Co, Schenectady, N. Y.*



Minimum excitation limits have been used since early applications of voltage regulators to synchronous machines. These limits were provided to prevent

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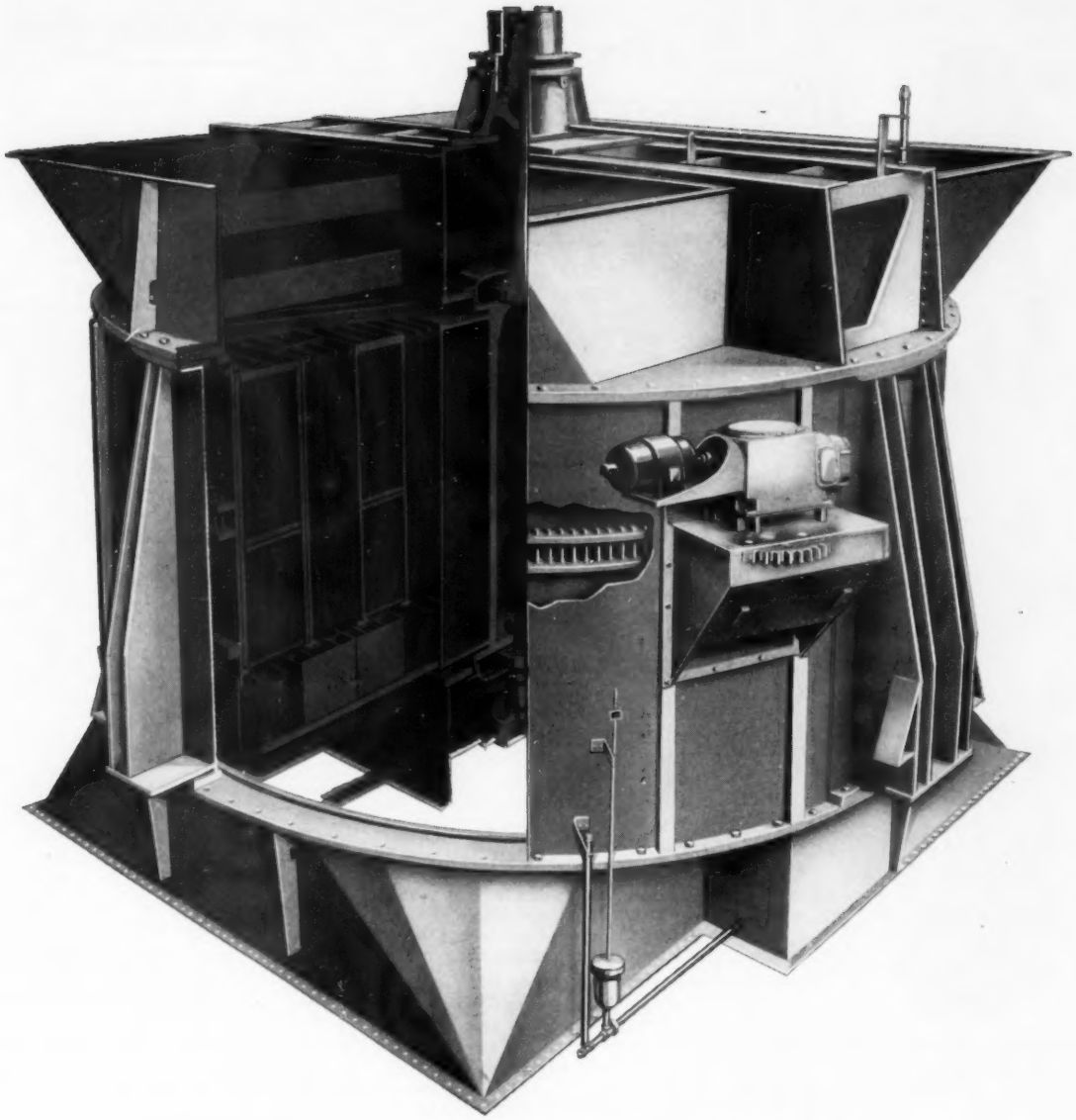


THE LJUNGSTROM AIR PREHEATER

cuts fuel costs in hundreds of plants

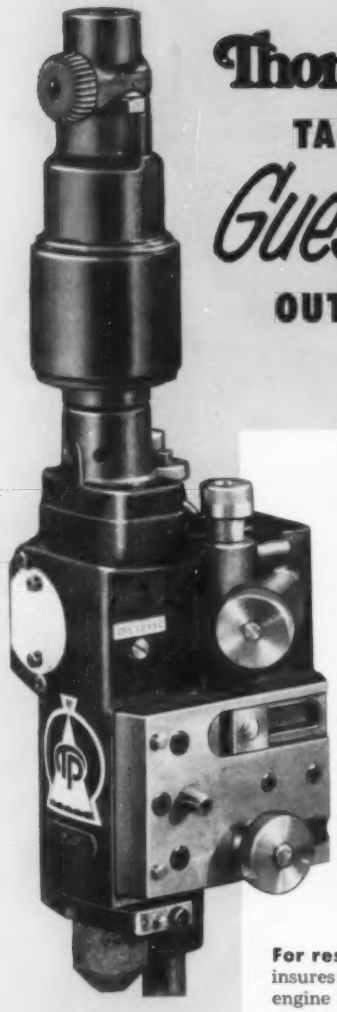
The Ljungstrom Air Preheater has proved its value in industrial and utility plants throughout the country. That's why every year, a constantly increasing percentage of the total installed boiler capacity is Ljungstrom-equipped. *Your fuel costs will drop, too,* when you equip your boilers with Ljungstroms. The extremely high efficiency of the regenerative design means the greatest possible recovery of waste heat . . . with substantially lower fuel requirements.

If you are planning a new boiler installation – or expanding or modernizing your present one – let our engineers show you how the Ljungstrom can raise over-all efficiency in your plant.

Ljungstrom Air Preheaters are now available for boilers of any type or capacity from 25,000 pounds of steam per hour up.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

THIS Thompson GRINDER TAKES BOTH THE *Guess and the Work* OUT OF VALVE SEAT SERVICING!



Valve seats and seat inserts from 3½" to 12" in diameter – whether cast iron or hardened alloy steel – can be ground with speed... with extreme accuracy... and easily with this Thompson Portable Valve Seat Grinder...

As a time saver it accomplishes in minutes a job that normally takes hours with ordinary reaming and hand-lapping methods.

For accuracy it grinds seats concentric with the valve guide within .003", is capable of holding tolerances to .001". It eliminates egg-shaped seats and produces a smooth, low micro-inch finish

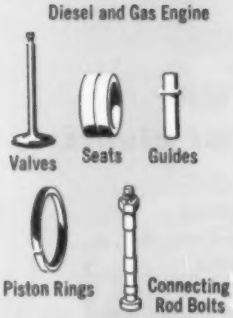
For easy operation the Thompson Grinder in the hands of any good mechanic produces precision ground valve seats on a production basis. Operation is simple, almost automatic.

For restoring engine efficiency this Grinder insures perfect valve and seat sealing for increased engine efficiency, longer valve and seat life and greater horsepower output.

Wherever big gas or diesel engines operate – on pipelines, in power plants, in refineries, in ships, *throughout industry* – the Thompson Grinder is saving thousands of maintenance dollars, shortening engine down-time and boosting performance.

These same savings can be yours! Write–today –for illustrated literature giving complete details, including prices, on the Thompson Grinder for *your* engines. No obligation, of course!

Diesel and Gas Engine



You can count on Thompson Products

WEST COAST PLANT • BELL, CALIFORNIA

Thompson Products, Inc., 8354 Wilcox Ave., Bell, Calif.

Please send me engineering data on the Thompson Portable Valve Seat Grinder. I operate: ☐ Gas ☐ Diesel engines with valve seats or inserts of_____diameter.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ **STATE**_____

More TECHNICAL BRIEFS

Begins on page 160

regulator from reducing ac machine-excitation to a value that would cause loss of synchronism. This paper describes operation and design of an underexcited reactive-ampere limit used with modern amplidyne voltage regulators, and discusses its purpose.

In 1947 first underexcited reactive-ampere limit was installed, using ac machine terminal voltage and current for determining limit characteristics. This limit was used with an amplidyne voltage regulator on a steam-turbine generator. It was designed to prevent loss of generator stability and basically accomplishes this by closely matching the static or dynamic stability limits of a generator. Desirable margin of stability can be predetermined and the limit accurately set to obtain this margin.

Extensive application of this limit has been made during past seven years, with amplidyne voltage regulators applied to steam turbine generators, hydro generators and synchronous condensers. Today, all amplidyne voltage regulators are supplied with underexcited reactive-ampere limit.

Underexcited reactive-ampere limit circuits shown in diagram consist of potential transformer with center-tapped secondary, limit-start variable autotransformer, resistor, power-recalibrating reactor and two isolating transformers, T_1 and T_2. Voltage from secondaries of isolating transformers is applied to discriminating circuit consisting of rectifiers F_1 and F_2, together with resistors R_1 and R_2, and an inverse-voltage limiting rectifier F.

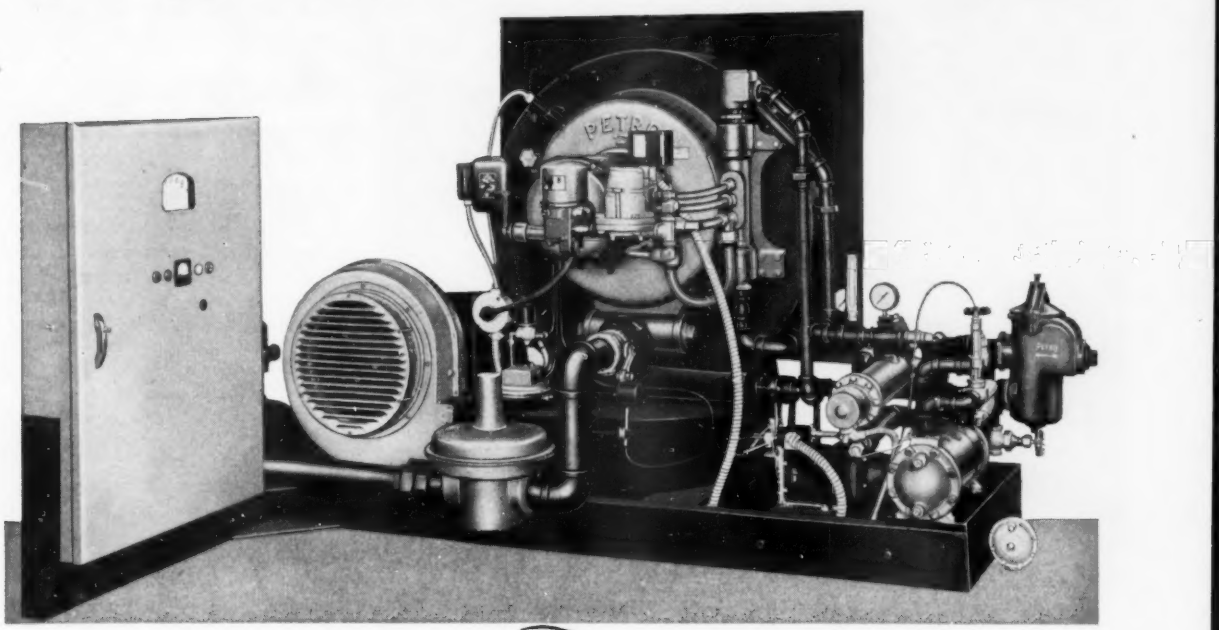
Limiting action starts when underexcited reactive current reaches preset value. This causes voltage across transformer T_2 to exceed the voltage across transformer T_1. Voltage across rectifier F_2 will also be greater than that across rectifier F_1. Current will thereflow flow in voltage regulator to cause it to hold a higher machine terminal voltage. When underexcited current is less than preset value, voltage across transformer T_1 will be greater than voltage across transformer T_2. In turn, voltage across rectifier F_1 will be greater than that across rectifier F_2. Under this condition, blocking rectifier F will prevent current flow to voltage regulator. Therefore, voltage regulator is not affected by limit circuit when underexcited reactive current is less than preset value.

Underexcited reactive-ampere limit gives confidence to user in initial application of voltage regulators to ac machines. With modern voltage regu-

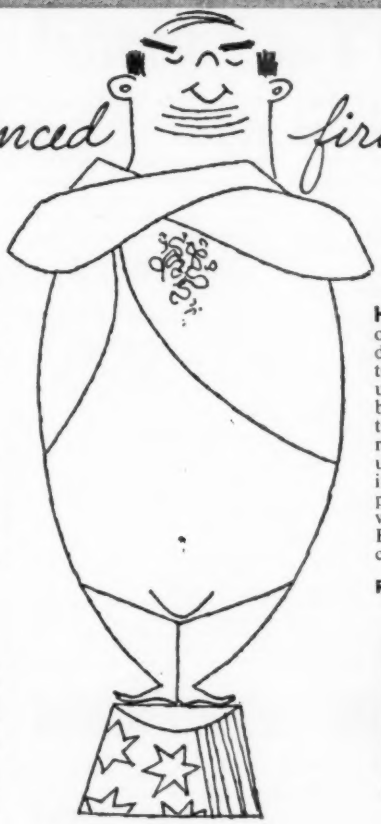
Directions for ordering papers on p 162

Petro

COMPLETE PACKAGED UNIT OIL, GAS, OR OIL-GAS COMBINATION BURNERS



a perfectly-balanced firing system...



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More TECHNICAL BRIEFS

Begins on page 160

lators, limit gives user confidence to operate machines underexcited. Finally, it enables user to capitalize, to a large degree, on underexcited capability of ac machines as permitted by steady-state stability limits. *AIEE conference paper, available from the authors.*

Motor Protection

Loss-of-Field Protection for Synchronous Machines. *By R L Tremaine and J L Blackburn, both of Westinghouse Electric Corp.*

There is considerable discussion among electric-utility engineers regarding need for automatic loss-of-field or loss-of-excitation protection and form which this protection should take. This paper shows the need for such protection, describes a new loss-of-field relay and considers both round-rotor and salient-pole machines.

It is well known that excess heat resulting from continous operation of a generator with zero excitation will damage its rotor stator end fingers as well as the stator winding. The major question is how long this condition can persist without damage. A turbo-generator can run safely above synchronous speed with zero excitation for about two or three minutes. There are numerous examples of machines that have run out of synchronism for varying periods of time without apparent damage. The maximum known to the authors is 17 min on a 10,000-kw, 25-cycle machine. From a review of the literature, the authors have been unable to find any clear-cut cases of actual damage to machines as a result of loss of field.

It is safe to reapply the field to a machine that has momentarily lost excitation, even if the machine is not running at synchronous speed. Theoretical consideration of shaft torques resulting from reapplication of field indicates that these torques are within design values. There are numerous examples of machines that have momentarily lost synchronism through loss of field and have been resynchronized simply by reapplication of field.

If loss of field results from an operating error that can be corrected, or if another excitation source is available, field can be reapplied and machine will pull back into synchronism. Obviously, if field cannot be restored in a few minutes, then machine must be tripped off. It is desirable to reapply field fairly slowly to reduce synchronizing torques when machine pulls into step. If such

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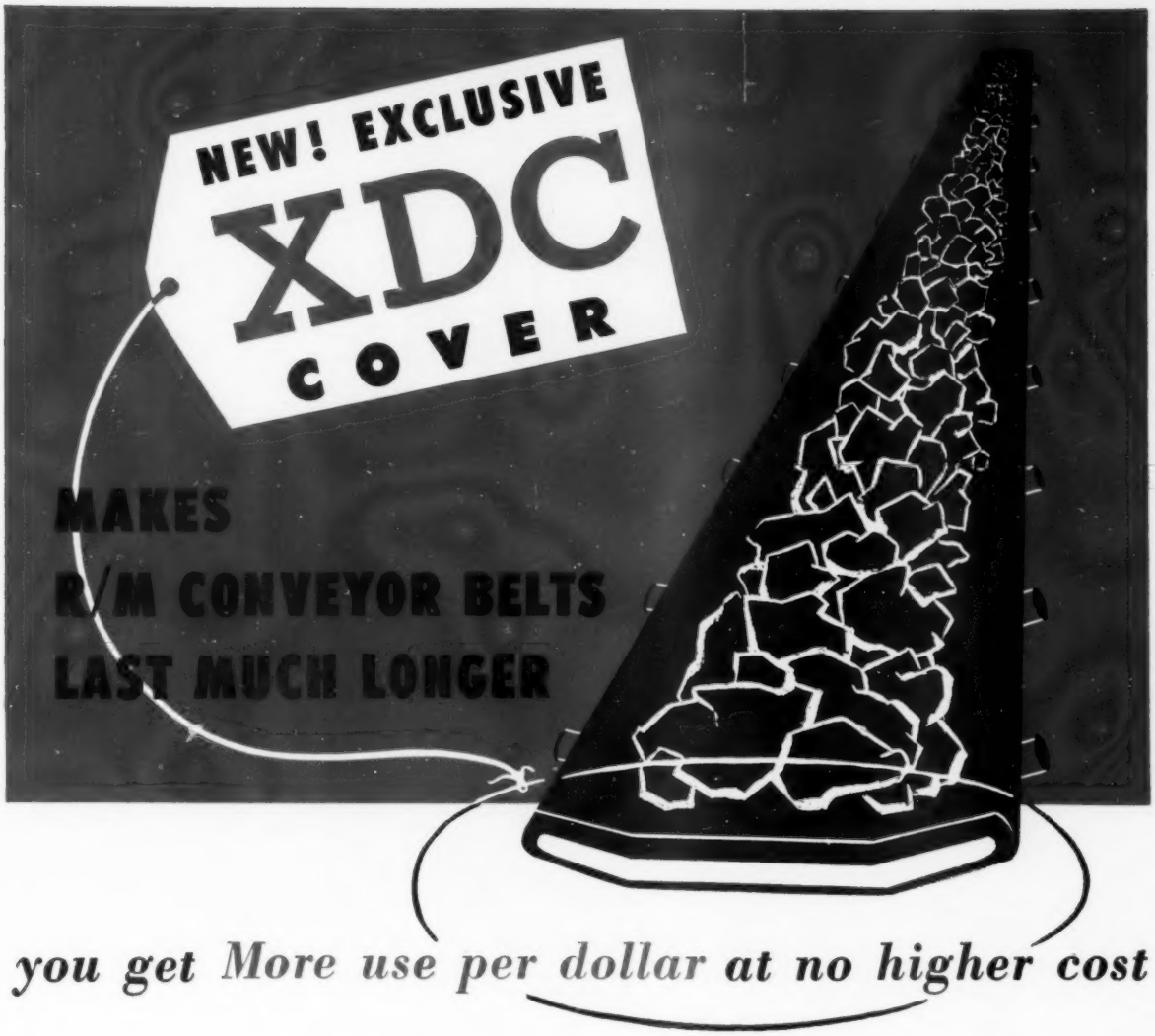

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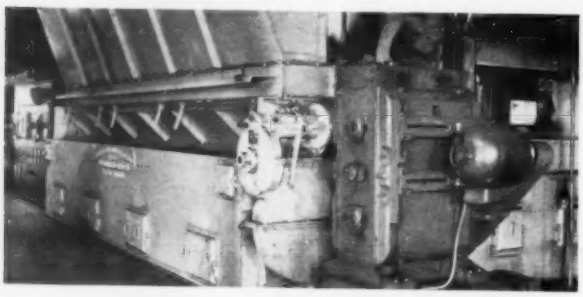

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More TECHNICAL BRIEFS

Begins on page 160

procedure is followed, an unnecessary machine outage can be avoided.

Contrasted with the fact that there is little evidence of damage to a machine through momentary loss of field, the effects on systems fall into two classes: (1) those in which there are little evidence of difficulty because system was stable, and (2) those in which system's disturbance was extremely serious. When a machine loses excitation a large magnitude of reactive vars flow into it. If the system can supply the vars without a serious reduction in system voltage, it will not be particularly adversely affected, but if the var flow causes a sufficiently low system voltage, instability between other machines on same system might result. Ability of a system to maintain stability is primarily a function of size of machine relative to system and action of voltage regulators. *AIEE paper, No. 54-113.*

An Electronic Power Supply for Integral Horsepower Motors. *By E G Cowie and J H Gregson, Canadian Westinghouse Co, Ltd, Hamilton, Ont.*

Variable-frequency power supplies are useful where a number of motor speeds are required. A typical bore-grinding machine requires three different induction motors to give required speed range of 20,000 to 100,000 rpm. These motors require frequencies of 480 to 1660 cps, and voltages of 190 to 270 v. In small installations the several motor-generator sets necessary to supply required range of voltages and frequencies are both expensive and require considerable space, and only a few such units are in operation at any one time. An electronic power source is well-suited to such applications because a variety of output voltages and frequencies are readily provided, as described in this paper.

The electronic power supply was designed to provide six frequencies from 480 to 1660 cps at a variety of voltages. Equipment operates from a 440-v, 60-cycle, 3-phase supply. Main power unit converts this supply to 400 and 600 v dc for power output and driver stages, respectively, of the three high-frequency channels, and to 150-v ac for blowers, filaments, transformers and control circuits.

Since driver and output stages are push-pull, no dc filtering is necessary. Power unit contains a circuit-breaker in supply line and in 150-v circuit. Time delay is provided to prevent premature application of plate voltage to driver and output stages.

Output of a conventional Wien bridge-

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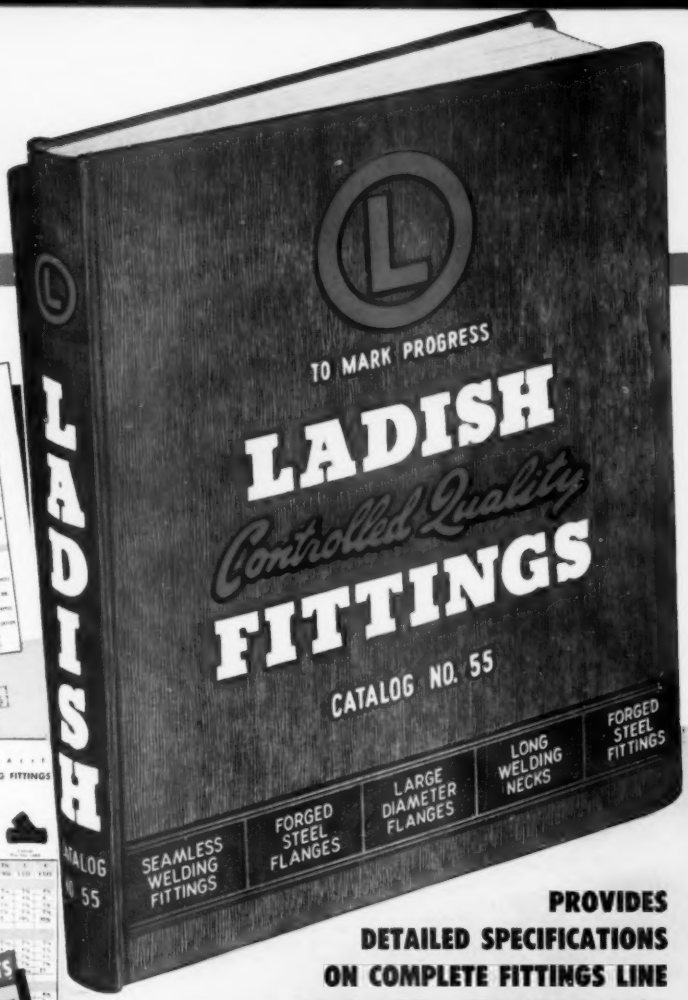

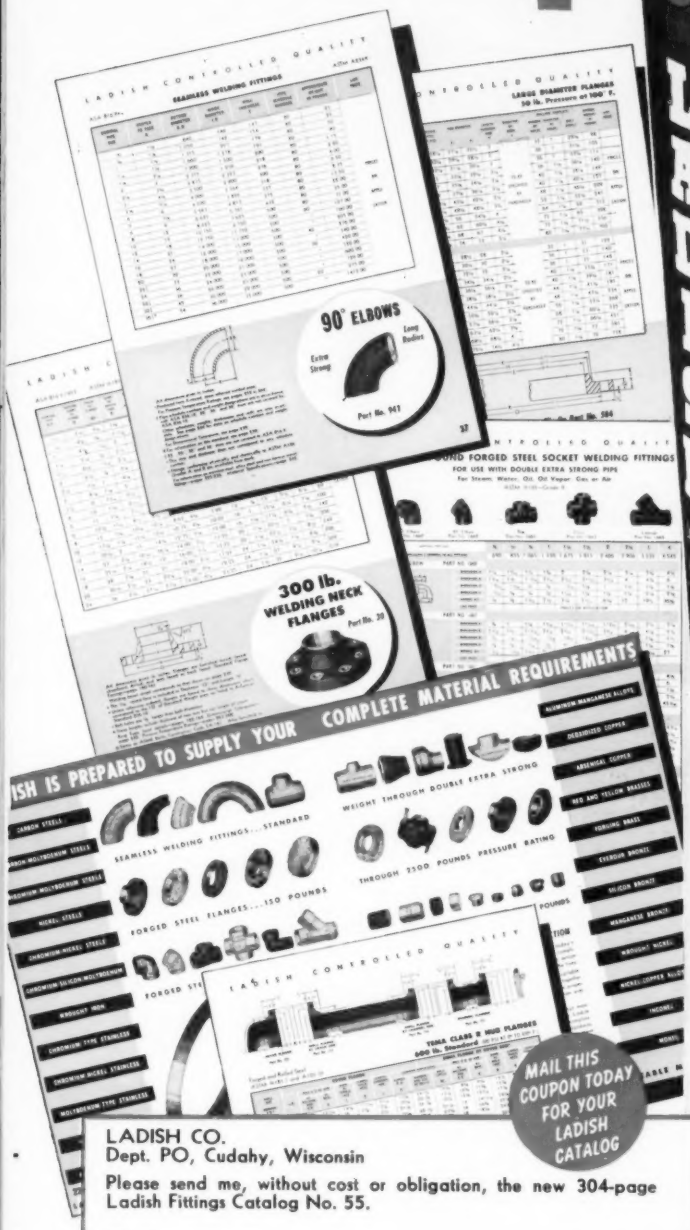

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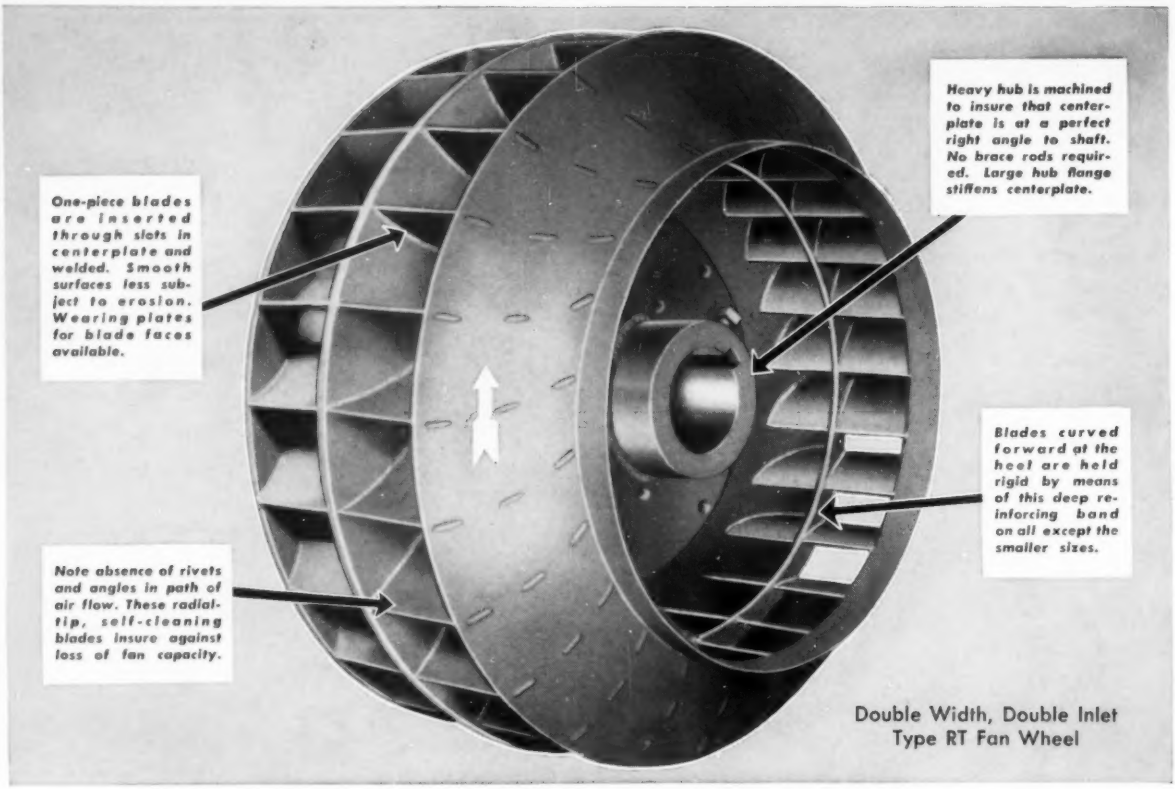
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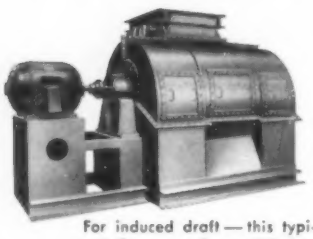
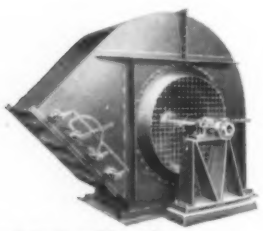


For induced draft — this typical Clarage Type RT fan.



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The illustration shows a 6-ton Mead-Morrison coal-unloading tower installed at the Cincinnati Gas & Electric Company's Columbia Power Station on the Ohio River . . . one of the many Mead-Morrison rigs that are making records for speedy, economical, dependable operation at steel mills and power plants.

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More TECHNICAL BRIEFS

Begins on page 160

oscillator is fed into phase-splitting and voltage-regulating circuit. Three output voltages from this stage feed three identical amplifiers for output stages. Secondaries of output transformers are connected in delta to give high-frequency power supply at any one of six frequencies. *AIEE Paper, No Number.*

Miscellaneous

Prevention of Babbitt Blisters in Thrust-Bearing Pads. *By R A Baudry, D W Gunther and B B Winer, Westinghouse Electric Corp.*

Extensive growth of hydroelectric power to a large degree depends on the development of reliable thrust bearings. Most of the pad thrust bearings put in service nearly 40 years ago are still in operation and show practically no wear or loss of efficiency. To operate satisfactorily, particularly during the starting period, thrust-bearing runners and pads must have bearing surfaces of highest standards of finish and flatness. Any part of the bearing surfaces higher than the normal oil film thickness will prevent satisfactory operation of the bearing and may cause its failure.

When a generator operates at rated speed, an oil film several thousandths of an inch thick exists between pads and runner. Since oil has a high electrical resistance, oil-film resistance can be used to check bearing performance. Low-resistance readings, as indicated by an ohmmeter, or even with a dry cell and light bulb, show that there are foreign particles in the oil film or high spots on the bearing surfaces.

Several years ago, temperature of a large thrust bearing showed a small but sudden increase and electrical resistance of the oil film dropped to a low value. The bearing continued to operate satisfactorily, but a scheduled inspection several months later showed some pads had shiny spots on them a few thousandths of an inch above their normal surface.

Even though the bearing had not failed, it was sent to the manufacturer for study and repair. Small holes drilled into the high spots released gas that was under high pressure. Some of this gas was collected and when analyzed consisted chiefly of hydrogen. Apparently high-pressure hydrogen had raised the babbitt from the steel and caused the blisters.

Further study and operating experience indicated that hydrogen-produced

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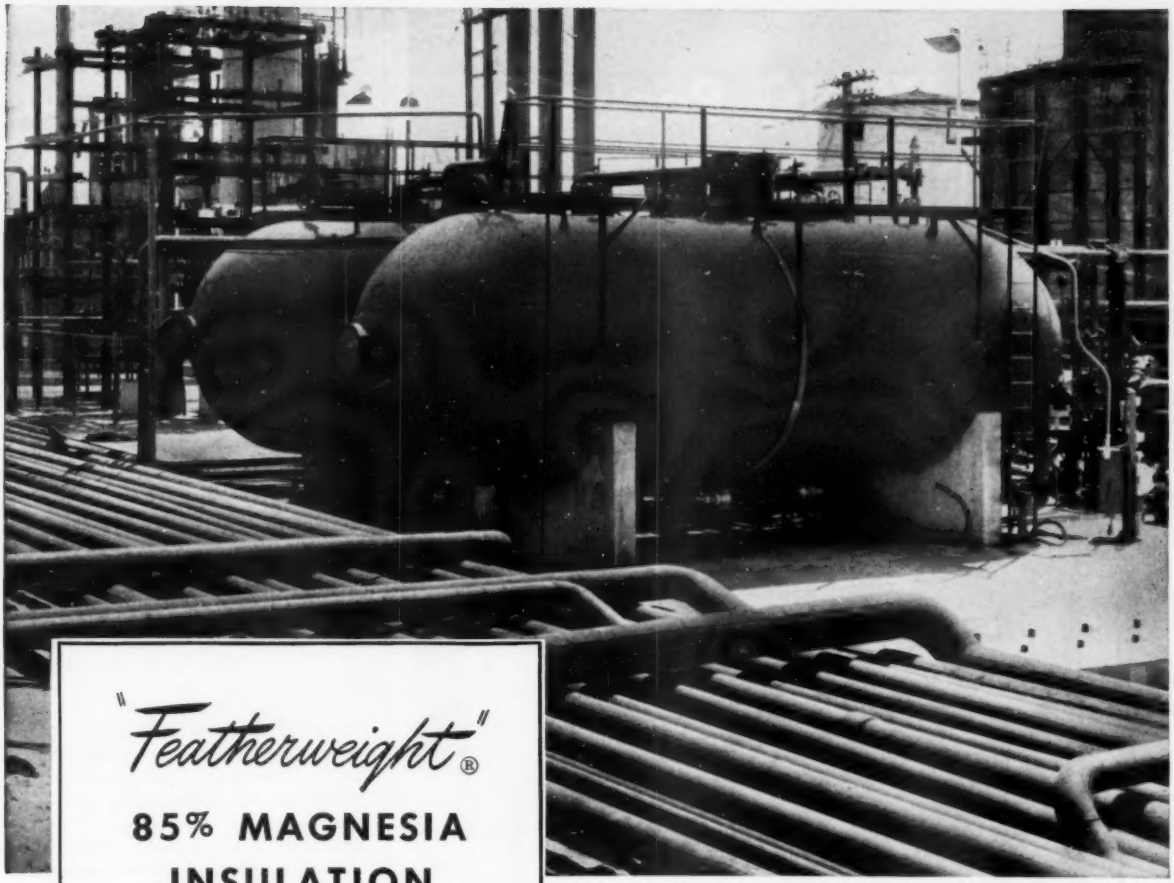

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"Save heat—save money" is an operating rule that holds true for almost every industry. In the refinery illustrated here, heat is effectively conserved by the use of "Featherweight" 85% Magnesia, used to insulate various pieces of hot piping and equipment.

For any industrial insulation use, "Featherweight" proves to be a thrifty choice. By itself this material (85% basic carbonate of magnesia and asbestos fiber) has an effective insulating range up to 600°F. Used with K&M Hy-Temp Insulation, its range is extended to 1900°F.

Hy-Temp is applied directly to the hot surface, and "Featherweight" is used as the second layer. The two materials, when applied with staggered vertical and horizontal joints, eliminate heat loss which occurs on single layer installations when the expansion of hot piping and equipment causes joints to open.

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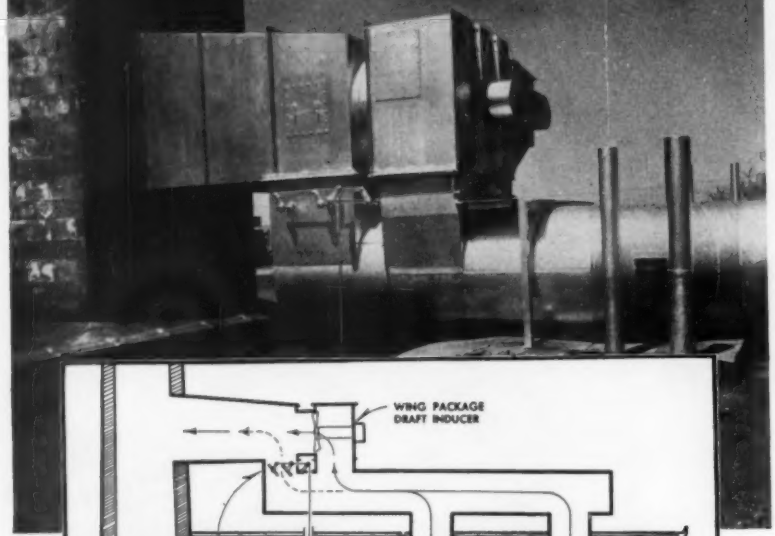

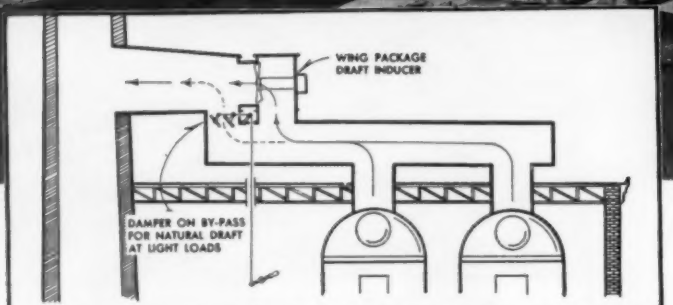

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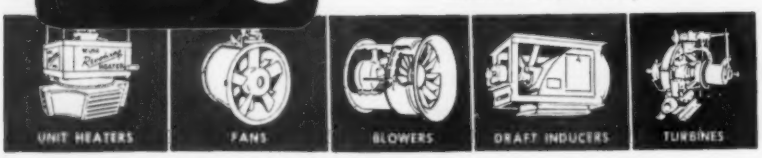

More TECHNICAL BRIEFS

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babbitt blisters were an important factor affecting thrust-bearing performance. Such blisters had been found on bearing pads that had been in storage for several years. But it had not been realized that these blisters could cause failure of a bearing. Such failures have occurred but were never explained because wiping the babbitt obscured the cause of the trouble.

Further study revealed that the hydrogen originated from within the steel, having been introduced during the steelmaking process. The maximum amount of hydrogen content to insure freedom from blistering was determined and processes to remove hydrogen from the steel were developed. Use of these processes in the manufacture of thrust-bearing pads has eliminated babbitt blistering. *ASME paper. No number.*

Coefficients of Float-Type Variable-Area Flowmeters. *By V P Head, Director of Hydraulic Research, Fisher & Porter Co.*

These types of flow meters have been on record since 1868 in the U. S. Many years passed before they found general use in chemical process industries, oil industries, aircraft test work and other flow measuring applications. This depended on development of precise glass and metal tube-forming techniques, and friction-free magnetic and electrical transmitters.

Working equations, based on dimensional analysis and theoretical pressure-drop relations, coupled with experiments, enabled development of coefficients to estimate performance of a wide variety of float shapes. These correlations are already in use in general application of industrial instruments. However, further test work with controlled float-edge sharpness and careful mechanical inspection is needed before a tolerance for uncalibrated test-type instrument can be stated with confidence. Whether this tolerance and inspection costs necessary to achieve it can compare favorably with tolerance and cost of individual calibration of test-type instruments remains to be seen.

Appendix contains tables of coefficients for ½, ¾, 1, 1½ and 2-in. flowmeters. *ASME Paper No. 53-A-208.*

Measurement Errors: Classification and Interpretation. *By J C Boonshaft, Chief Engineer, Fischer & Porter Co.*

Reliable measurement depends on complete understanding of appearance of errors, how they are affected by instrument construction and method of

Directions for ordering papers on p 162

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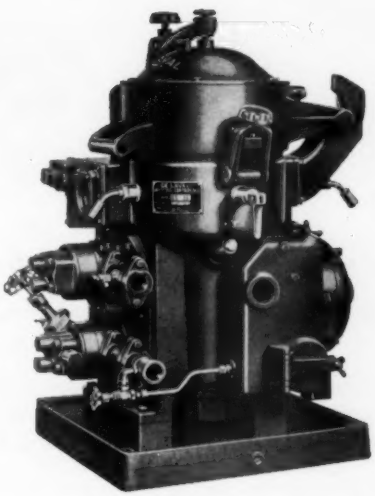
A De Laval Oil Purifier of proper size will clean all the oil in the system every six to eight hours. The exact rate of purification depends on the viscosity of the oil and the size and character of the contaminants. No getting around it, continuous purification provides continuous ***protection.***



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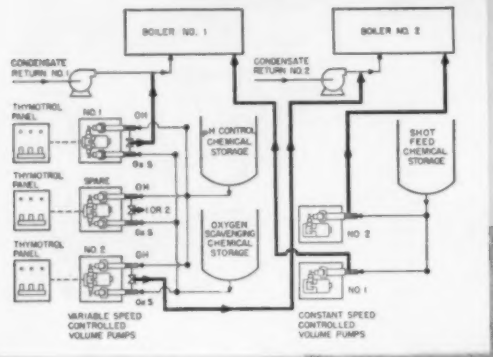
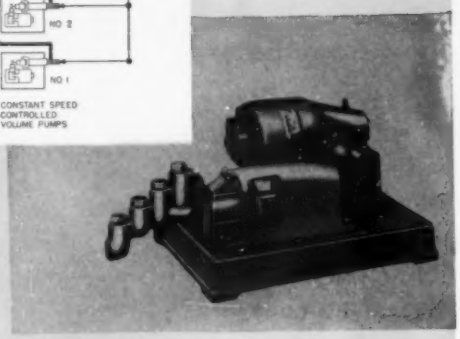
CONTROLLED VOLUME PUMPS ARE FLOW-CONTROL INSTRUMENTS





Major utility standardizes on controlled volume pumps

Philadelphia Electric utilizes Milton Roy pumps in connection with the boiler feed water treatment system in each of its seven power stations.

Standardization proves profitable. Automatically controlling the metering of treating chemicals, this universal treatment method assures complete control over many problems of power plant operation.

Flow-control instrumentation of this type is representative of the use of Milton Roy Controlled Volume Pumps. Other applications include flocculation control in clarifiers, corrosion control in boilers, and pH control.

Similar systems can help you solve *your* low-capacity flow control problems. Write for Data Sheet D-54-2 which describes fully the Milton Roy System . . . and Bulletin 553, "Motor-Driven Pumps."

Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa

MILTON Roy COMPANY

Manufacturing Engineers 1305 E. MERMAID LANE • PHILA. 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

More TECHNICAL BRIEFS

Begins on page 160

using the instrument. Accuracy depends on following: (1) How well is the true value known? (2) How well does the instrument measure this true value? (3) How well does the experimental method reduce uncertainties in comparison?

Errors depend on such items as: (1) scale factors (2) direction of approach of variable to final reading (3) just-past history of measurement system (4) length of time at reading (5) life history of measurement system (6) ambient factors, particularly temperature.

Scale factors include readability, closest being 0.1 or 0.2 part of smallest scale division, unless verniers are used. Readability depends on physical layout of scale and its relation to the pointer or indicator.

Dead zone in instruments depends on sensitivity to small changes in value of variable. Dead zone is measured by total change in variable (both up and down) before instrument responds. Instrument sensitivity is related mostly to force, friction ratio of receiving element to linkage system and accessory units' element drives.

Just-past history of an instrument involves sensitiveness that is measured by small changes of variable. It usually stays constant throughout the range. Another factor is hysteresis which is measured throughout full range of instrument. Hysteresis can be limited by selecting metals with closely controllable physical properties.

With certain inexpensive steels used in many instrument springs, instantaneous reading errors as high as ½% of full scale may be experienced. It may take as much as 24 hrs for this error to reduce to zero through recovery of springs. This effect is only important in high-precision work with quick changing variables.

Time effects of permanent set or change in calibration because of creep, leakages, chemical changes within measuring element can be eliminated by periodic recalibration. Instrument manufacturers usually put their products through full cycling tests to "break in" equipment and to test for poor construction.

Principal ambient temperature errors result from change of elastic modulus and consequent range calibrations. Special materials or design can minimize this type of error.

Measurement uncertainties from smallest to largest are: readability, sensitiveness, dead zone, elastic after-effect, hysteresis, permanent set and precision. *ASME Paper No. 53-A-219.*

(*Continued on page* 216)

Directions for ordering papers on p 162

"You see POWELL VALVES everywhere!"

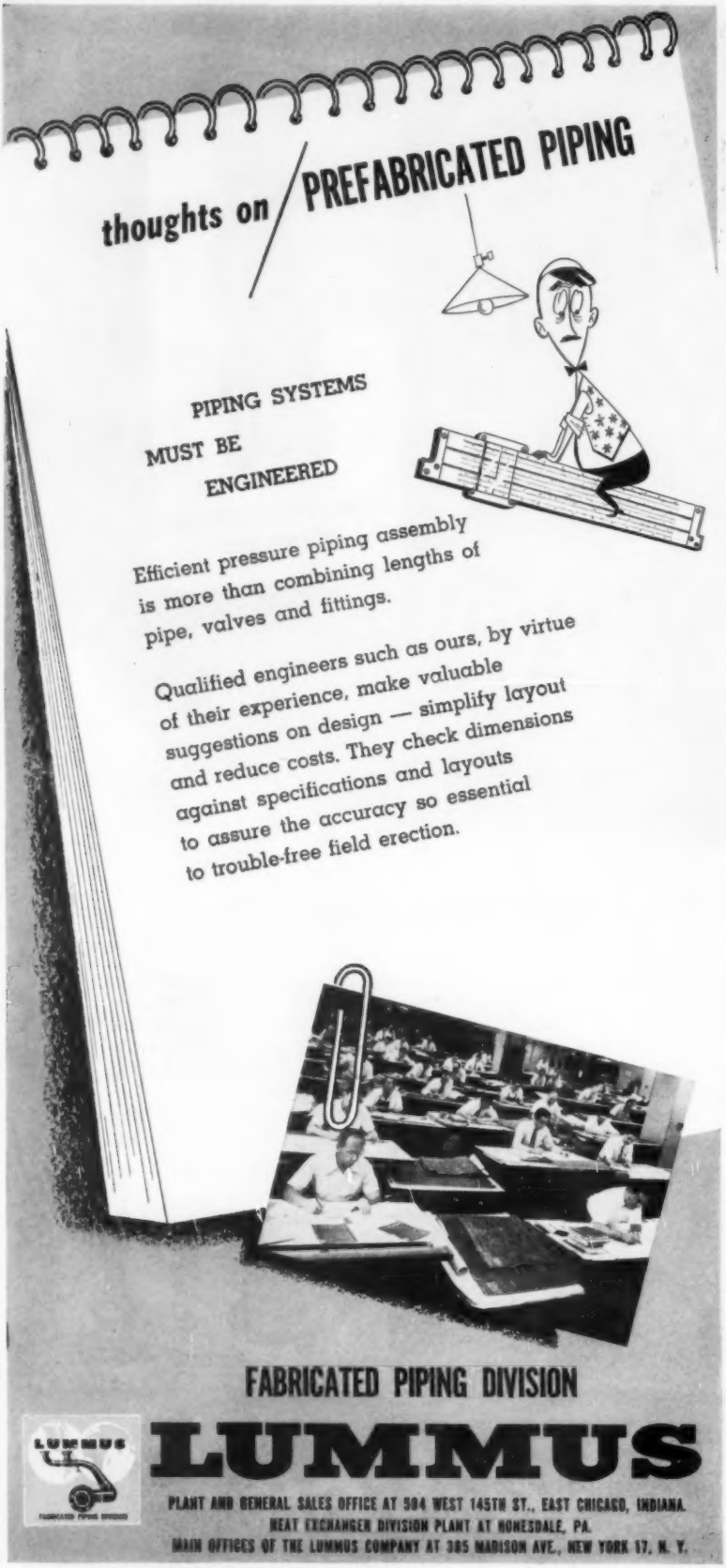
And no wonder! For The William Powell Company makes more kinds of valves and has probably solved more valve problems than any other organization in the world.

Wherever flow requires dependable control, there's the place for Powell Valves—famous for dependability since 1846. Made ⅛" to 30" and 125 pounds to 2500 pounds W. S. P. Bronze, iron, steel and corrosion resistant alloys. Available through distributors in principal cities. On problems, write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

CONTROLS FOR THE LIFE LINES OF INDUSTRY

Powell Valves

108th year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ENGINEERED
Efficient pressure piping assembly is more than combining lengths of pipe, valves and fittings.
Qualified engineers such as ours, by virtue of their experience, make valuable suggestions on design — simplify layout and reduce costs. They check dimensions against specifications and layouts to assure the accuracy so essential to trouble-free field erection.
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More TECHNICAL BRIEFS

Begins on page 160

Some 12 Percent Alloys for 1000-F to 1200-F Operation. *By D L Newhouse, B R Seguin and E M Lape, Materials and Processes Lab, General Electric Co.*

These alloys include some martensic 12% Cr types. Detailed high-temperature creep-relaxation and stress-rupture data are given for 12% Cr (Type 403) and for six alloy modifications including 12% Cr-Co-W-V, 12% Cr-W-V, 12% Cr-Mo-V, 12% Cr-Mo-W-V, 12% Cr-Cb and 12% Cr-Ni-W. Other properties such as thermal expansion, modulus of elasticity, resistance to stress corrosion and so forth, are discussed. Some of the modified 12% Cr alloys offer a combination of properties that make them attractive for a number of high-temperature applications.

These materials prove their importance in steam and gas-turbine buckets, compressor blading, bolting, valve stems and similar applications. The paper includes five extensive tables of properties of these alloys and 14 graphs. *ASME Paper No. 53-A-168.*

Survey of Experimental Determinations of Heat Capacity of Ten Technically Important Gases (Air, NH_3, CO_2, CO, H_2, CH_4, NO, N_2, O_2, H_2O). *By J F Masi, Thermodynamic Section, National Bureau of Standards.*

All literature reports of determination of heat capacity of gases in period 1925-1952 have been reviewed and those pertaining to any of the ten gases have been tabulated. The four direct and six indirect methods used in these measurements are described. Reported results of several of the gases are compared graphically with values calculated from molecular data and an equation of state. A table of most recent heat capacity values for the ten gases at one atmosphere is included.

Bibliography lists a total of 53 references. Appendix describes a flow calorimeter used by National Bureau of Standards. *ASME Paper No. 53-A-206.*

New firm—Jordan, Shotwell Associates, 50 Broad St, New York 4, N. Y.—offers general consulting service with emphasis on industrial power and process design and construction management. Walter Jordan has had long experience in processing of non-metallic minerals and participated in construction of the gaseous diffusion plant at Oak Ridge.

Dr John S G Shotwell, formerly chief of Construction Management Bureau, Northeast District Corps of Engineers, has had an extensive background in Canada and the United States in power construction, plant layout, management engineering and is a specialist in pulp-and-paper operations.

YOU CAN'T SEE WASTE HEAT!

CONTROL OF EXCESS AIR BY CITIES SERVICE HEAT PROVER CAN REDUCE HEAT LOSSES AT CEMENT PLANTS! In cement kilns, air must be controlled to the precise quantity that will just completely burn the fuel. Any excess of air above this amount carries waste heat out of the kiln. THE HEAT PROVER ENABLES THE OPERATOR TO SEE WHEN THE RIGHT AMOUNT OF AIR IS ENTERING THE KILN.

Many air-measuring methods allow only intermittent sampling of kiln gases. With the Heat Prover, direct and continuous readings of kiln combustion are available for immediate use . . . and the Heat Prover can bring about a considerable fuel savings and can substantially increase just about any cement plant's operating efficiency.

WHEREVER A FURNACE OPERATION IS INVOLVED the Heat Prover can help increase productivity and decrease operating costs. It samples rapidly and provides simultaneous and continuous readings of oxygen and combustible gases. The Heat Prover is portable—a technically accurate combustion analysis is obtained in a usable, practical manner. For details call your nearest Cities Service Office or write Cities Service Oil Co., Sixty Wall Tower, New York 5, N. Y.

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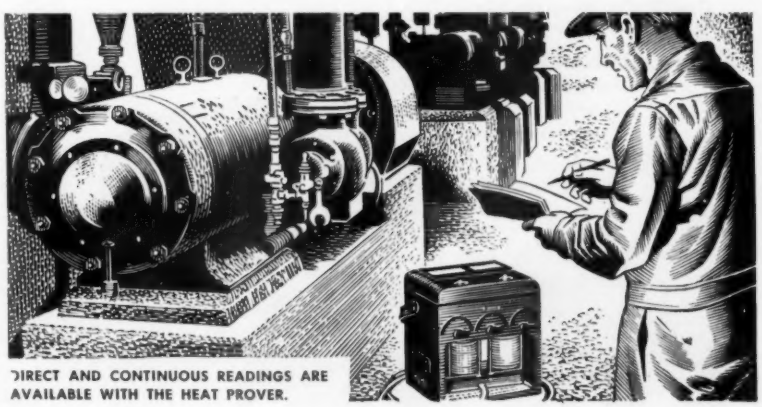
QUALITY PETROLEUM PRODUCTS



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Constructed of a thoroughly digested mixture of the highest grade carded Canadian Asbestos fibre, with special compound, this gasketing is used for the sealing of water, steam, all oils, gases, alkalies, acids, refrigerants and hydrocarbons. Every square inch of sheet has a uniform density, thickness and asbestos distribution.

DURABLA Gaskets do not leak or show distress at 1650 psi, steam pressure at 850° F. Gaskets are supplied in all sizes and shapes accurately machine cut.

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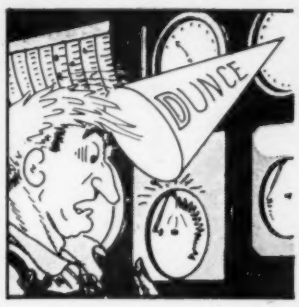


My Biggest Boner

► I'LL NEVER FORGET the misery of a 12-8 watch in a 400-psi 750-F pulverized-coal fired plant in which I pulled the biggest boner of my life. I had the upper level in the boiler room; the other fireman on watch was assigned to the lower level.

About 4 am he signalled me he was ready to wash ashes and wanted the induced draft on No. 2 boiler increased. I strolled over to the control panel and casually switched from automatic to manual control of the induced draft. Then I turned the knob to increase the draft. This control was often sluggish, so I carefully watched the gage pointer. For some reason or other it seemed slower than usual.

Suddenly the engineer in charge of the watch dashed in, shouting that his superheat temperature and vacuum were dropping fast. "What's wrong?" he yelled.

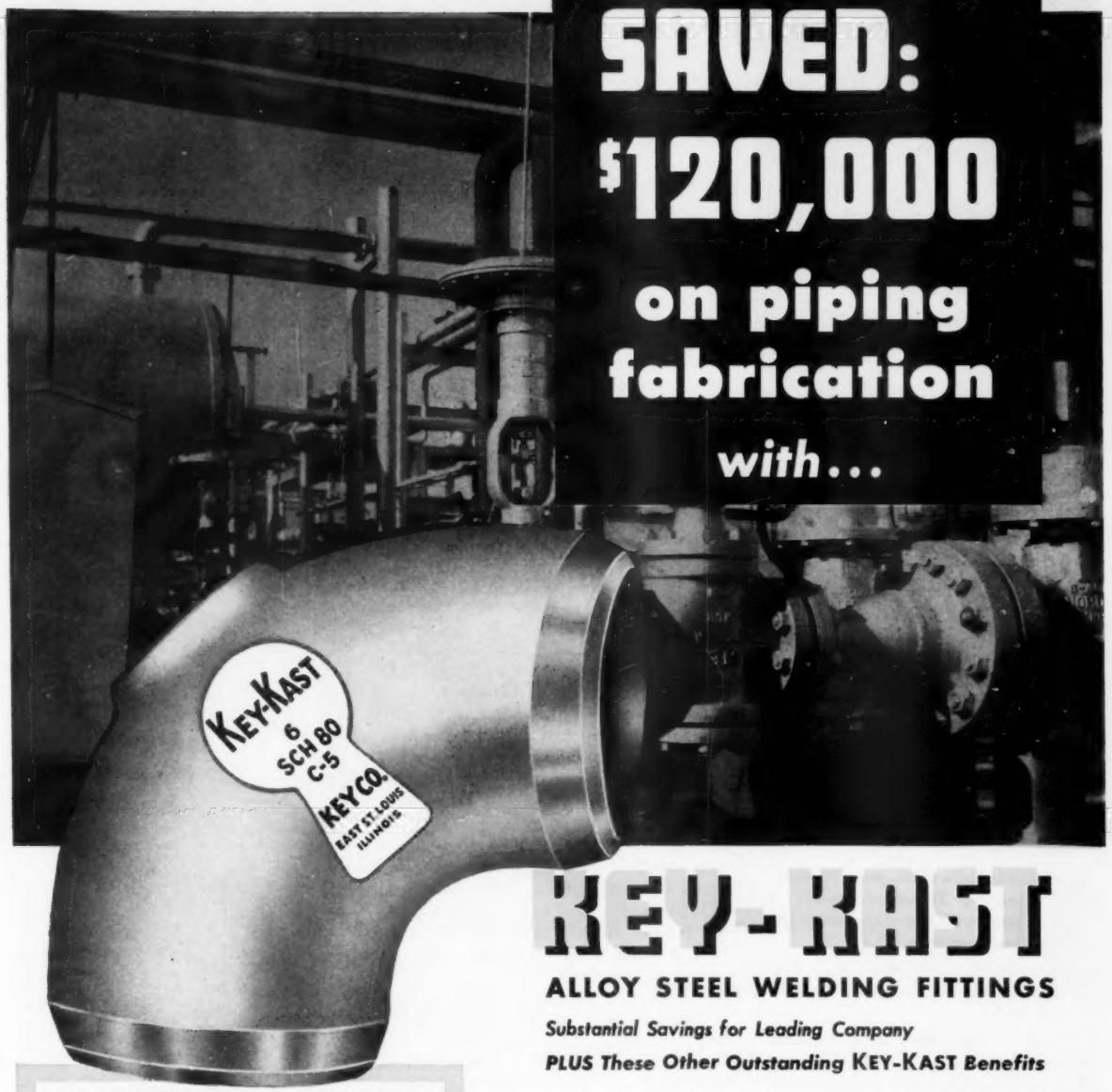
I looked at him as though he had tripped his governor and quietly replied: "Nothing." Then I glanced at the feedwater flowmeter and, to my amazement, the pen was ready to run off the outside of the chart.

In a foggy moment I had grabbed the feedwater control and was increasing feed instead of draft. The high water alarm wasn't working, so we had no warning of the increase in boiler water level.

I've never forgotten this boner. Now, whenever I approach a control panel, I set my mind to my job. And I keep it that way.

MAURICE KELLY
Philadelphia, Pa.

● What is your biggest boner"? We'll pay ten dollars for each one we publish.



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ALLOY STEEL WELDING FITTINGS

Substantial Savings for Leading Company

PLUS These Other Outstanding* KEY-KAST *Benefits

1. Delivery of fittings was on *schedule* with the pipe.
2. Quality of the fittings was consistent throughout, with not one rejection.
3. Although KEY-KAST fittings were *not* ordered to radiographic quality—all weld ends were gamma rayed and KEY-KAST fittings showed up better than class 2 per ASTM E-71.

IN ALL SHAPES, SIZES, SCHEDULES IN LOW AND INTERMEDIATE ALLOYS AND VARIOUS STAINLESS STEELS

Write for information and prices

Since 1916 . . . manufacturers and developers of products for high temperatures and pressures

GIVE YOUR PIPING SYSTEM THE ADVANTAGES OF KEY-KAST ALLOY STEEL WELDING FITTINGS

- Greater wall thickness throughout with *extra* thickness in critical areas.
- Lower unit cost.
- Materials meet A.S.M.E. and A.S.T.M. Codes.
- Rigidly tested and inspected to meet high standards of quality.

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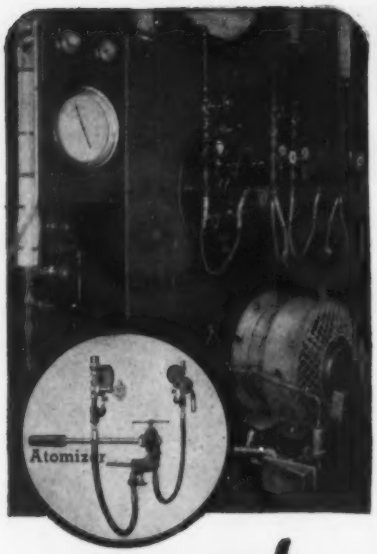

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FOR ALL GRADES OF LIQUID FUEL

Enco Burner Units of Steam or Mechanical Atomizing Types are made in various sizes with capacities from 1 to 1000 gallons per hour.

Designed for operation either with or without air registers and for natural or forced draft.

The Enco Interchangeable Atomizer is made for instant change of guns for operation by either steam or mechanical system or to cover a wide range of capacity.

Enco Atomizers are used with various types and makes of pulverized-coal and gas-burner units to provide a dual fuel unit for cold starting, or for full-load operation when coal or gas is not available, or use when oil is the more economical fuel.

We have made many installations during the past 25 years and are ready to cooperate with those looking for better operation and assurance against loss of steam output.

THE ENGINEER CO.
Enco 75 West St. New York 6, N.Y.

More POWER NEWS

Begins on page 158

This reactor, known as Pressurized Water Reactor (PWR), will be cooled and moderated by ordinary water under pressure. Using slightly enriched uranium as fuel, this type of reactor is more advanced, research and development-wise, than others.

This project represents only one of several approaches to development of economical electric power production from atomic reactors. A total of five atomic power plants have been planned by the Atomic Energy Commission. A few details were revealed by Dr Henry D Smyth, Member of AEC, at a meeting of the American Institute of Chemical Engineers in New York on March 9.

The first power reactor, the PWR mentioned above, will generate at least 60,000 kw. Water in the reactor at 2,000 psi and 500 to 600 F will heat other water to produce steam at 600 psi for turbine drive.

No. 2 will be a "breeder" of intermediate size. The term "breeder" refers to a reactor that generates not less than 1 lb of plutonium or U233 for each pound of U235 consumed. This unit will generate up to 15,000 kw of electric power. "Temperatures and steam pressure will be increased to values appropriate to a full-scale power breeder reactor." The quotation compares the new plant with the small experimental breeder that has been running in Idaho for some time.

Plant No. 3 is a radical simplification. It will be an attempt to use boiling water as the medium for heat extraction. It is planned to feed steam generated in the reactor directly to a 5,000-kw turbine, a possible way to reduce costs of atomic power plants.

Fourth unit planned by AEC will be a homogeneous reactor designed to breed uranium U233 in a blanket of thorium surrounding the chain-reacting core. This unit will produce 65,000 kw of heat, but no electric power.

Reactor No. 5 will use graphite as moderator and a sodium-potassium alloy as coolant. To test this combination, the reactor will generate about 20,000 kw of heat, but without any electrical generation.

Dr Smyth brought out several other points of interest: The nuclear power industry must stand or fall economically depending on success chemists and chemical engineers have in developing cheap processes or purifying and refabricating nuclear fuel.

The submarine "Nautilus", recently launched, will use pressurized water for cooling and heat transfer. The second submarine reactor may use pure sodium as coolant.

(*Continued on page 222*)

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

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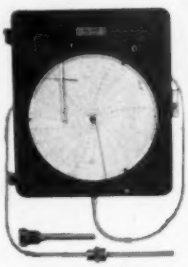
Temperature Indicating Instruments



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Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

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Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

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Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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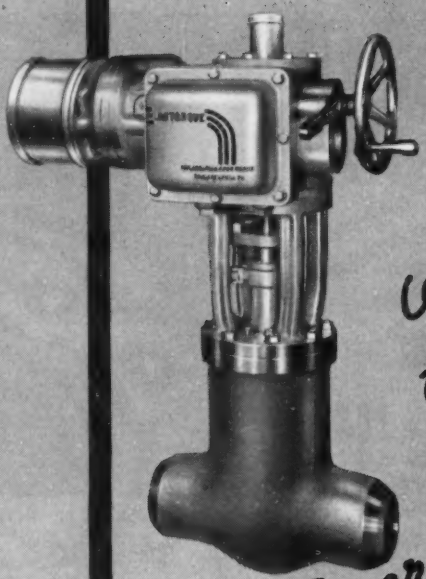
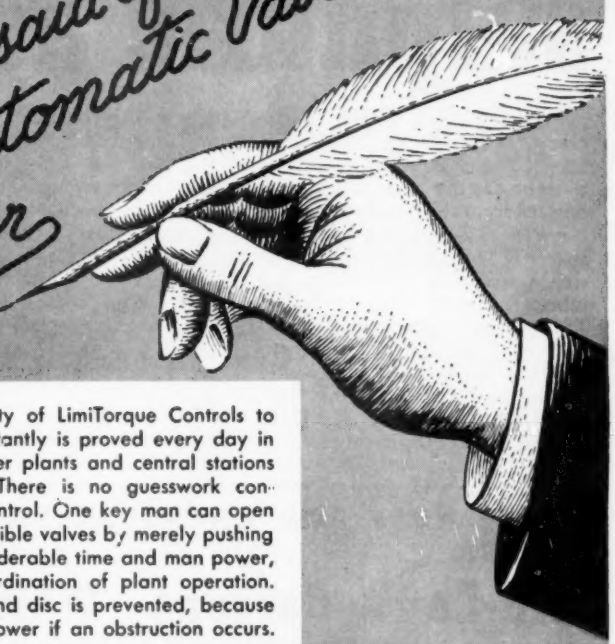
is absolutely dependable



what more can be said of any Automatic Valve Operator



The unfailing dependability of LimiTorque Controls to function surely, safely, instantly is proved every day in many of the leading power plants and central stations throughout the country. There is no guesswork connected with LimiTorque Control. One key man can open and close large or inaccessible valves by merely pushing a button, thus saving considerable time and man power, while assuring better coordination of plant operation. Damage to seats, stems and disc is prevented, because LimiTorque shuts-off the power if an obstruction occurs. LimiTorque fits all types of valves and may be actuated by any available power source such as electricity, air, steam, water, gas or oil.

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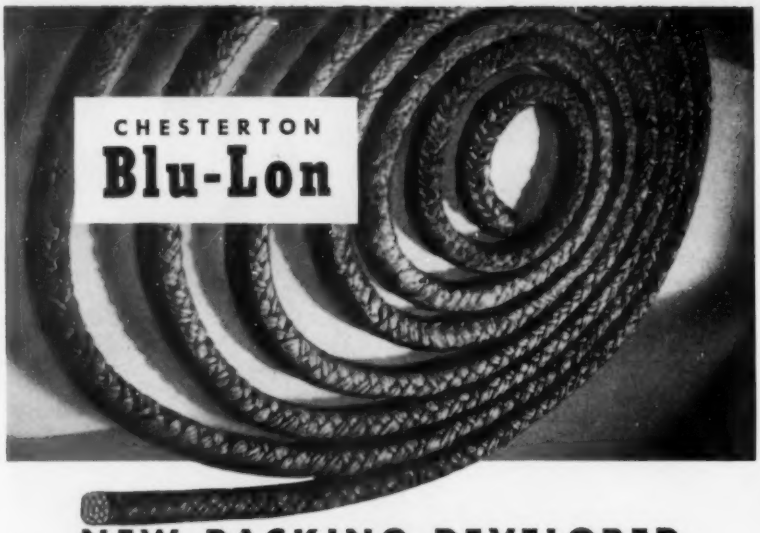

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Sulphuric Acid, Nitric, Hydrocloric, in fact on any Acid* Blu-Lon, Chesterton Style 320, makes a tight lasting seal. Blu-Lon is braided from chemically pure African Blue Asbestos and through a specially designed method each single strand is immunized and lubricated with DuPont Teflon. This process is not to be confused with other quick dip Teflon treatments as Blu-Lon is a thoroughly impregnated Teflon packing. This added protection plus Blu-Lon's unique breaking-in lubrication places this packing in an Acid resisting field by itself.

Chesterton Blu-Lon is recommended for strong acids of 1–4 pH value. Note chart below which recommends three Chesterton Packings for full range of chemicals 1–14 pH.

Blu-Lon comes thoroughly lubricated, *ungraphited*, blue in color. It is ideally suited for service on chrome plated or stainless steel shafts.

** For Hydrofluoric Acid write us for special recommendation.*

A SAFE RULE FOR CHEMICAL PACKINGS

#320 Blu-Lon	#315 Carsons	#322 White-Lon
1 TO 4	5 TO 10	11 TO 14
STRONG ACIDS	WEAK ACIDS OR ALKALIES	STRONG ALKALIES

pH PACKING SCALE

PACKING Chesterton SERVICE

A. W. CHESTERTON CO. • EVERETT 49, MASS.
America's Oldest Manufacturer of Mechanical Packings

More POWER NEWS

Begins on page 158

The power produced by all of the proposed plants will be many times as costly as power from conventional plants, but Dr Smyth feels that atomic power will eventually be competitive. All of the industry groups that have been studying the matter have come to the same conclusion, he said.

Gas Turbine

(*Continued from page* 158)

TURBINE wheel is prepared for testing

stage centrifugal and a rotary regenerator gives a light, compact and simple machine with fuel consumption comparable to that of automotive . . . engines."

The Chrysler turbine and its reduction gears are 32 in. long, 33 in. wide and 28 in. high. It is rated at 120 shaft hp, according to George J Huebner Jr, executive engineer in charge of research and director of the development. Because of its torque characteristics, Huebner said, the turbine delivers about the same performance as a 160hp piston engine. It is about 200 lb lighter and has only about 20% as many major moving parts as a piston engine of the same output.

"Whether we ultimately shall see commercial production of gas turbines for passenger cars," said James C Zeder, vice-president and director of engineering and research, "depends on the long-range solution of many complex metallurgical and manufacturing problems."

Test runs of the turbine car, burning straight-run gasoline, were made at the Chrysler proving grounds. This is believed to be the first gas turbine used successfully in a production-model car. Chrysler tentatively plans to test-run the car for the press in June.

(*More Power News on page* 224)

80% saving on lubrication costs

by just letting Pure Oil help them SIMPLIFY AND SAVE!

HERE'S HOW YOU CAN SAVE

1. **Reduced inventory**
2. **Simplified inventory control**
3. **Reduced labor cost**
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Be *sure* with Pure. Sales offices located in more than 500 cities in Pure's marketing area.

When a West Virginia coal mine found they were spending more than 5¢ per ton for lubrication, and loss of tonnage through breakdown was even more, they called in Pure Oil.

Within six weeks Pure Oil engineers had cut the cost down to 1¢ per ton (a savings of 80%). How? By selecting lubricants better suited to protect the machinery and, by setting up a lubrication program based upon a survey. Reducing the number of lubricants from seven to four resulted in smaller inventory and less waste. An unusual case, to be sure. Yet sizable savings have been accomplished in all types of mines, mills and factories by similar Pure Oil methods.

Send for this *free* booklet which tells you how you can *Simplify and Save* on lubrication, too!

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Please send me your free booklet on how to "Simplify and Save"

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ALBRIGHT STATION*

Monongahela Power Company
Fairmont, West Virginia

Units #1 and #2 are in operation. The fans for Unit #3 have been designed and are being constructed. They will be larger than the fans for the first two units. Boiler #3 will operate on the same type of fuel (pulverized coal) and is expected to generate one million pounds of steam per hour.

Each boiler now in service is served by two Forced Draft and two Induced Draft Fans with the following specifications:

F. D. Fans Double inlet with radial inlet vanes; outlet dampers; rain hoods and recirculating duct connections. Capacity for each fan: 110,500 cfm; 100 F; 14.7" SP; 1180 rpm; 348 hp.

I. D. Fans Double inlet, special control type inlet dampers and outlet dampers. Capacity of each: 187,000 cfm at 350 F; 13.5" SP; 880 rpm; 566 hp.

Green Fans can show an excellent record of efficiency and durability. They can be found in many of the leading and recently completed utility and industrial power plants. They have back of them a fund of knowledge about fan requirements and fan design. They serve their users well.

Our Catalog No. 168 tells all about Green Fans. Write for a copy.

*Sanderson & Porter, Engineers

THE GREEN *Fuel Economizer* COMPANY INC.

- Economizers
- Fans
- Air Heaters
- Cinder traps
- Aerodyne Dust Collectors

BEACON 3, NEW YORK

More POWER NEWS

Begins on page 158

Bevatron goes into operation

► UNIVERSITY OF CALIFORNIA'S *Bevatron*, the world's most powerful particle accelerator, has gone into successful operation. Built with AEC funds, the $9-million machine has accelerated hydrogen protons to an energy of 5-billion electron volts (bev), the highest energy ever achieved by an accelerator. UCRL physicists are now working to push the machine to its design energy of 6.25 bev.

Experimental attention will be focused especially on mesons created by collision of high-energy protons with particles in target nuclei. Production of mesons is one of the chief missions of all modern high-energy particle accelerators. Sometimes called the "glue" of the atomic nucleus, the meson is intimately involved with the powerful but elusive forces that are responsible for the atom's great energy.

Westinghouse paper explains the technical writing field

► WESTINGHOUSE ELECTRIC CORP has prepared a comprehensive paper entitled: *Technical Writing Opportunities for Engineering Graduates* that is designed to show interested engineers the best way to start a career in this field.

This latest memorandum on technical writing was prepared by H C McDaniel, manager of technical publicity, and C A Scarlott, editor of the *Westinghouse Engineer*. Copies of it have been sent to the editor of each college engineering magazine published in the United States and to the editor of *Industrial Science and Engineering*.

Purpose of this paper is not to teach engineers how to write, but rather, to show them the best ways to get technical articles into print. Any person interested in this information may obtain a copy of the memorandum by writing Westinghouse Electric Corp, Technical Publicity Dept, PO Box 2278, Pittsburgh 30, Pa.

Plan memorial to Albert L Cole

THE MEMORY OF Albert L Cole, late power production superintendent of Saskatchewan Power Corp, Regina, Canada, and former Associate Editor of POWER, will be perpetuated in Saskatoon, Saskatchewan. The utility's power plant in that city will be renamed the Albert L Cole Generating Station.

The company will also establish a memorial library for him, in its Regina office. Cole died in 1952.

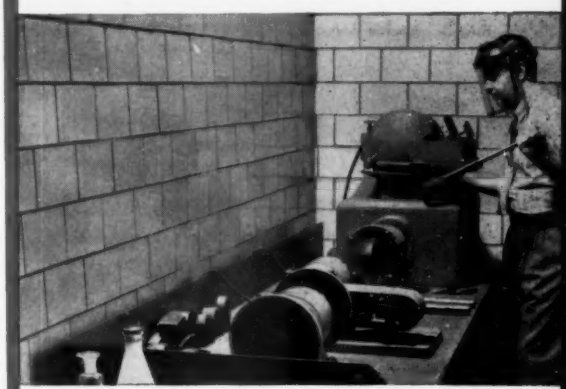
(*More Power News on page* 226)

Heat-treating and physical testing equipment shown at left is used for quality control of welding operators and for development of new welding procedures.

This Rockwell hardness testing machine measures the hardness of weld specimens as a guide to proper procedures for heat-treating of welds.

Daily rigid testing is your insurance of quality welds in

NAVCO FABRICATED PIPING



A laboratory technician cuts a sample from a pipe weld prior to grinding and polishing for metallographic examination.

At Navco, a continuous parade of weld specimens are processed in the new, modern physical-chemical testing laboratory. It is here that weldments are studied metallographically and tested physically—all on a rigid schedule of quality control practices. Navco customers have benefited from progressive quality control practices for more than 40 years; they have come to know that piping installations, engineered, fabricated and erected by Navco, are precise, accurate and dependable.

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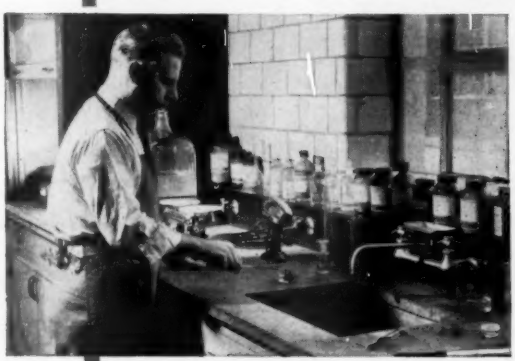

Here a weld specimen is etched to outline the grain structure for further metallographic study.

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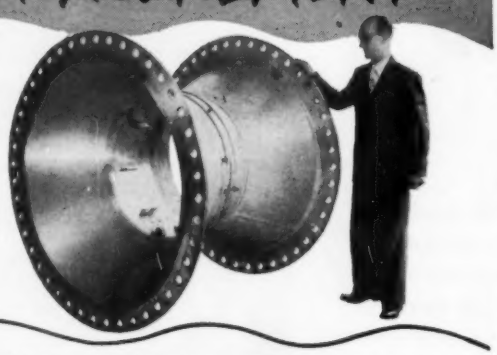

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More POWER NEWS

Begins on page 158

Coming Events

May 5-7—American Institute of Electrical Engineers. Northeastern district meeting. Hotel Van Curler, Schenectady, N. Y. For details write AIEE, 33 W 39th St, New York 18, N. Y.

May 7—First Annual Conference for Engineers, Ohio State University, Columbus, Ohio. For details write ACE, Room 100, Lord Hall, Ohio State University, Columbus, Ohio.

May 16-20—Oil Heat Institute of America. Twentieth exposition. For details write R H L Becker, Oil-Heat Institute of America, Inc, 500 5th Ave, New York 36, N. Y.

June 13-18—American Society for Testing Materials, annual meeting, Sherman and Morrison Hotels, Chicago, Ill. For details write ASTM, 1916 Race St, Philadelphia 3, Pennsylvania.

June 14-17, American Society of Mechanical Engineers. Annual conference and technical exhibit of the Oil and Gas Power Division. Muehlbach Hotel, Kansas City, Mo. For details write ASME, 29 W 39th St, New York 18, N. Y.

June 21-25—American Institute of Electrical Engineers. Summer and Pacific general meeting. Biltmore Hotel, Los Angeles, Calif. For details write AIEE, 33 W 39th St, New York 18, N. Y.

June 28-30—The American Society of Heating and Ventilating Engineers, 60th semi-annual meeting. New Ocean House, Swampscott, Mass. For details write ASHVE, 62 Worth St, New York 13, N. Y.

July 13-15—Plant Maintenance Show and **Plant Maintenance Conference,** Pan-Pacific Auditorium, Los Angeles, Calif. For details write Clapp & Poliak, Inc, 341 Madison Ave, New York, N. Y.

Sept 1-16—International Electrotechnical Commission, golden jubilee meeting at University of Pennsylvania, Philadelphia. For details write US National Committee, American Standards Association, 70 E 45th St, New York 17, N. Y.

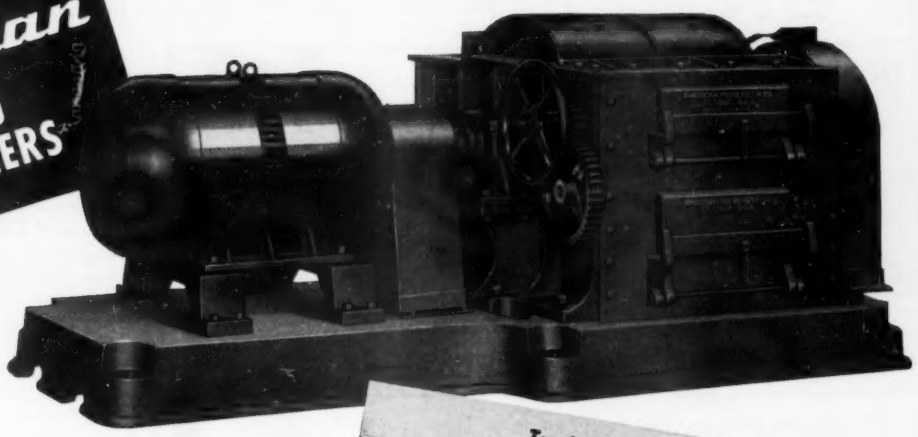
American Society of Mechanical Engineers has appointed Ketchum, MacLeod & Grove, Inc to handle its public relations activities, according to C E Davies, ASME secretary. In addition to its regular public relations activities, the agency will be responsible for drawing up recommendations for celebration of the society's 75th anniversary during 1955.

The $36-million expansion of the power plant at Arrecifes, west of La Guaira on the central Venezuelan coast will be ready for service in late 1955. This project will increase capacity of the plant to 300,000 kw. Now oil-fired, the plant will be supplied with natural gas from the Guarico fields.

CRUSHING UNLIMITED!

the story of 61,000,000 tons of coal crushed at less than 1¢ per ton!

American rolling ring COAL CRUSHERS



The facts are in! The story of American Crusher performance—rugged, long-life-low-cost performance—is now available for your careful study. Not just one case history, or scattered reports—but a thorough survey of American installations (power plants, central stations, and mines) across the nation. Here are the "crushing" facts:

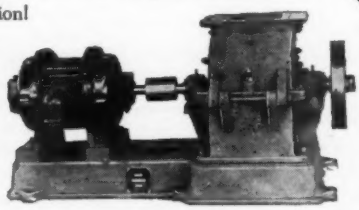
Total Tonnage Handled .....61,000,000 Tons
Average Age of Crushers .....9.5 Years
Replacement Parts (Including Standby Parts) 1/10 of 1¢ per Ton

There can be no better proof of American's superlative endurance and economy of operation!

Typical Survey Results

LOCATION	CRUSHER	TONNAGE	PARTS REPLACEMENT COST
N. J. Central Station	42-S	6,000,000 Tons	$.00025 per ton. 20-year-old installation!
W. Va. Industral Power Plant	38-S	10,008,000 Tons	$.0008 per ton. 10 years in service!
Illinois Coal Mine	AC3-E	4,000,000 Tons	$.0005 per ton for 10 years service!
W. Va Coal Mine	38-S	2,514,000 Tons	$.0007 per ton. 23 years old!
Ill. Power Plant	42-S	2,950,000 Tons	$.0004 per ton. 6 years in service.

. . . and for low-cost coal sample crushing



Model 15 x 9 American Sample Crusher (one of several sizes) with capacities up to 2,000 lbs. per hr. Can be equipped with American Adjustable Sampling Hopper, for a 5%-10%-15% or 20% sample of a sample.

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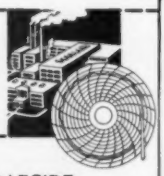
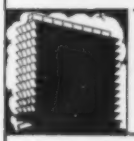
2 WESTERN BOILER FEED WATER TREATMENT

Special formulas for each individual boiler water and operating condition to eliminate scale, corrosion and foaming.





3 COOLING WATER TREATMENT AND ALGAECIDE

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More PLANT PROBLEMS

Begins on page 140

Cleaning stacks

Continued from page 142

either at base or top of the lining. These can be filled with rich cement mortar or neat cement. But lower temperatures or installation of more lining is necessary to stop further damage.

GG should carefully distinguish between soot and cinders. The latter can be economically removed with cinder-collecting fans, cyclone collectors, electrostatic collectors or gas scrubbers.

PETER CUSHING *Chicago, Ill.*

EDITOR'S NOTE: *Many plants run into the problem of removing soot from the stack interior. While no single solution gives positive results in every plant, it is interesting to note that washing down with water or other fluids, sandblasting and use of a steam lance require careful study before the job is started. Corrosion, erosion and cracking are a few of the troubles that occur with the wrong cleaning method or the right one incorrectly applied.*

Talks with a number of plant operators show there is a growing tendency to use outside contractors for soot removal because the investment required for the equipment is difficult to justify. Not only that, with fewer operators per boiler, not enough men are available for the work.

So approach soot removal carefully. Get all the facts on job costs and results before deciding on any particular method. Then you'll be certain you're using the best cleaning method for your plant and its equipment.—Ty Hicks

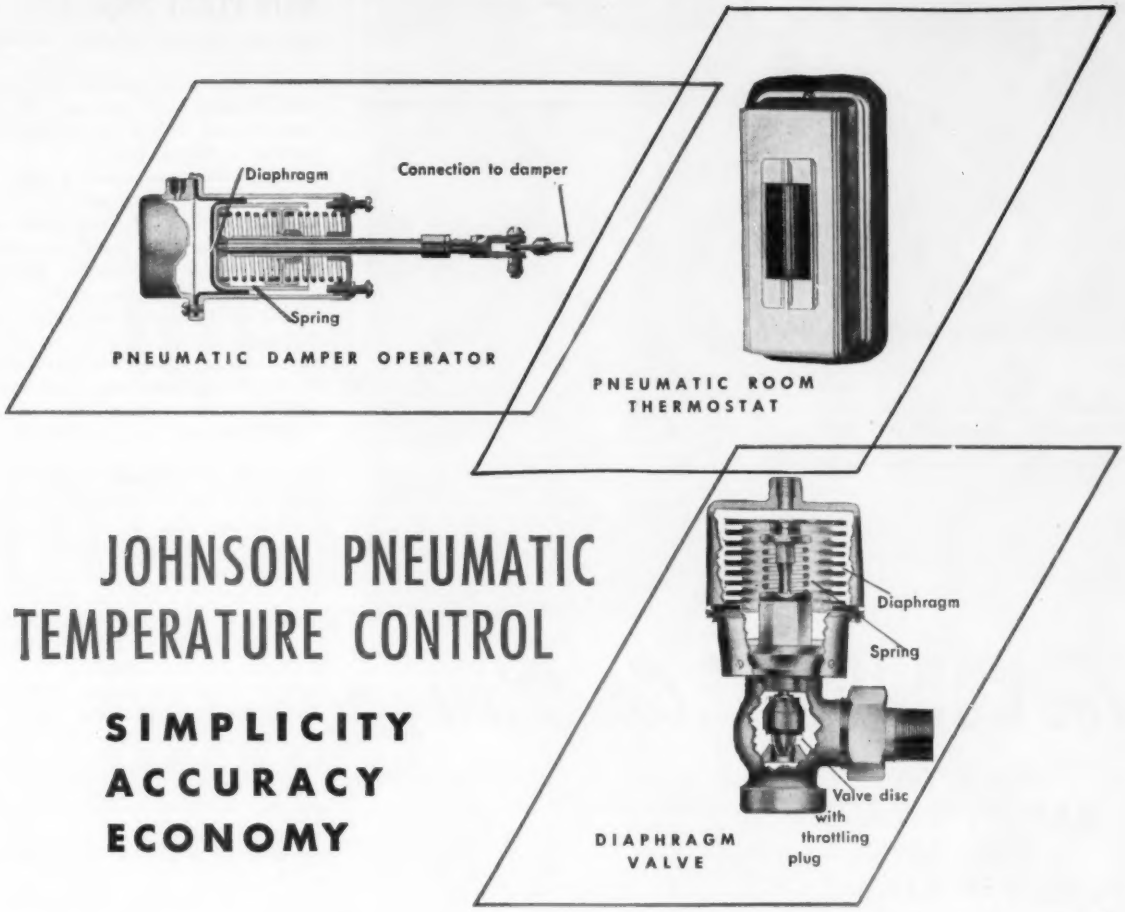
Reconnecting generator

Continued from page 144

number of poles and each coil is connected to adjacent commutator bars. For the wave winding the number of paths through the armature is always two, and each coil is connected to commutator bars about two pole pitches apart. (A pole pitch is the distance measured on the armature between the center lines of adjacent poles.)

In a 4-pole wave winding one half the coils are in series while in the 4-pole lap winding, one-fourth of the coils are in series. So the output voltage of the wave winding is double that of the lap winding. With this arrangement the power output is the same because while doubling the output voltage the output current is halved.

Field coils are usually connected in series because field-rheostat power loss is less and the control equipment is lighter. Commutation problems may in-



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Pneumatic power—compressed air—is simplicity itself, adaptable, dependable, economical . . . In the automatic regulation of temperatures and humidities, for example, Johnson *Pneumatic* Control has been the standard since the '80's.

Each Johnson controller is merely a reducing valve in a compressed air line, set and reset automatically by an accurate temperature or humidity measuring element, to transmit compressed air, at varying pressures, to the valves and dampers which it controls. Johnson Diaphragm Valves and Damper Operators, too, are simple devices, with flexible, long-life diaphragms which are inflated as the controllers transmit increased air pressure.

There are no mysteries here. And no complications! The operating cost of Johnson pneumatic equipment is very low—the only expense being the operation of a small compressor to supply air pressure. Where special conditions make it desirable, Johnson furnishes other types of apparatus, such as electronic temperature and humidity controllers, to operate either pneumatic or electric operators.

Attesting to the accuracy, dependability and adaptability of pneumatic control are thousands of Johnson Automatic Temperature Control Systems in textile mills, chemical and food processing plants, schools, hospitals, hotels, shopping centers, airports, office buildings, apartments, and many other types of buildings. The next time you have a temperature control problem, an experienced engineer from a nearby Johnson branch office will gladly prove to you how it can be solved most efficiently by Johnson *Pneumatic* Control. Johnson Service Company, Milwaukee 2, Wisconsin. Direct Branch Offices in Principal Cities.

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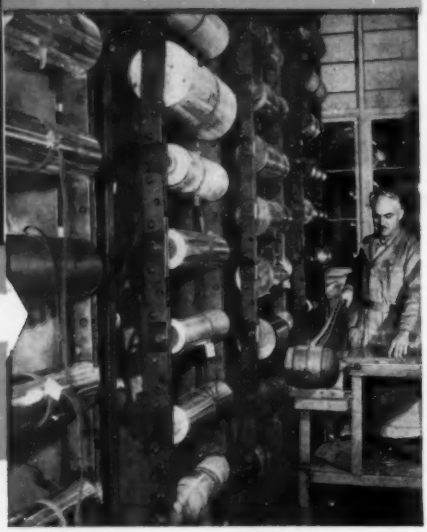

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The recommended disc to use under these circumstances is the BS&B Kel-F lined rupture disc, which has for more than 3 years proven its resistance to corrosive attack from strong acids, caustics, chlorine, etc. Kel-F is a trade name for a thermo-plastic film of trifluorochlorethylene, which is also known by the trade name of Trithene. Discs may be specified with the Kel-F lining on either or both sides, as your conditions may require.

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For full information on the BS&B Kel-F lined rupture disc and its application to your specific problem, consult your BS&B Office or Representative . . . or write to us direct.

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More PLANT PROBLEMS

Begins on page 140

crease because the brushes of the 4-pole wave winding short out two coils at a time whereas with a lap winding only one coil is shorted out.

Generators are designed to make maximum use of field current and in the interests of economical and stable operation it is not good practice to deviate from this rated field current. This does not tell the whole story because other factors like interpoles, series field, front and back pitches, must be considered. Since most machines are wave wound, *JS* should not have too much trouble with his reconnecting job.

M P Beattie *Clifton, N. J.*

ONE ARMATURE CONDUCTOR must cut 100 million lines of force per second to generate one volt. So the voltage produced by a generator depends on the speed at which the lines of force are cut. This, in turn, is a function of number of lines of force per pole, speed of armature rotation and number of turns in series between the brushes.

JS cannot change speed of his generator. So this means the number of turns per coil in the armature windings have to be increased. If the generator has 10 turns per coil of 4000 cm area and runs at 120 v, then by changing to 20 turns per coil of 2000 cm area, he can generate at 240 v at the same speed and kw output.

Field will have to be rewound. If connected two in series, two in parallel, they can be reconnected to four in series to generate 240 v.

F R Hayworth *Arlington, Mass.*

CARBIDE & CARBON

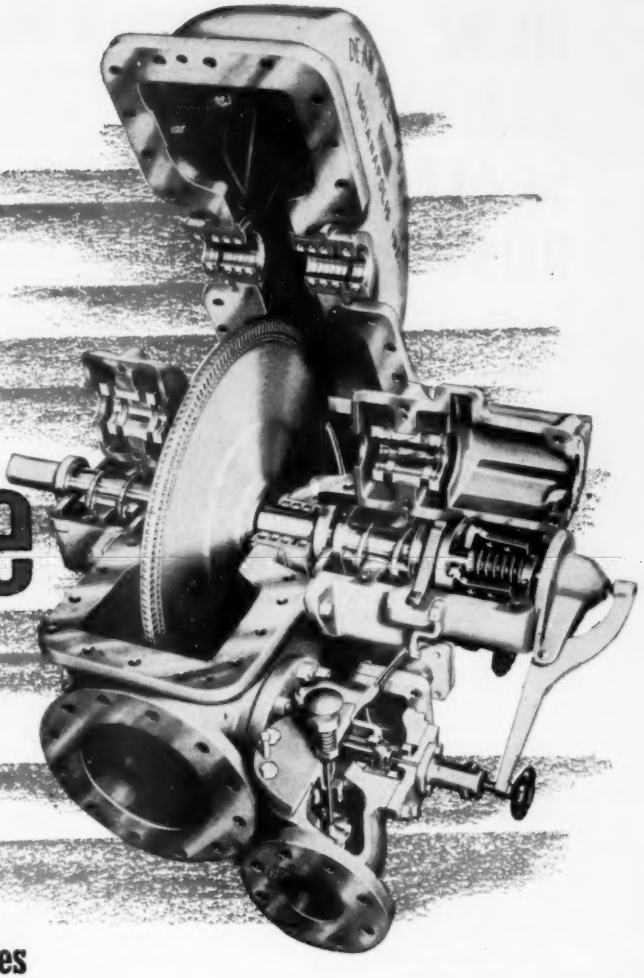
Continued from page 93

fan turbine speed. Since the fuel-gas supply varies in heat content, the system has been designed so that fuel-to-air ratio can be biased at the boiler panel. A glance at the excess-oxygen indicator-recorder tells the operator how well the system is performing.

Control of boiler-water level is handled by a 4-element feedwater regulator that takes its impulse from steam flow plus blowdown, and balances this against feedwater flow and boiler-drum level. Output of this regulator is imposed on the feed-pump-turbine speed-control valve. Solenoid-operated bypass valves provide low-flow protection for feed pump by sending feedwater directly to the deaerator when metered flow is less than 40,000 lb per hr.

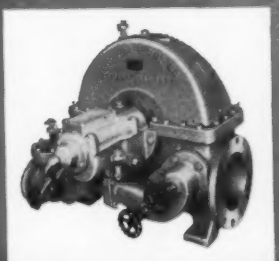
Pressure-reducing and desuperheater valves are remotely operated from the

up to 100% more power



added to DH turbines

More power from the same size unit! Dean Hill presents an improved DH Line of horizontal turbines which produce up to twice the power of former counterparts.



The major change contributing to this tremendous power increase is the addition of one or more steam nozzles to all models, with these results . . .

1. The new, two-nozzle DH-10 and DH-20 turbines have *double* the maximum horsepower of former units.

2. Models DH-30, DH-40 and DH-45, now with three nozzles, are rated 50% higher in maximum horsepower.

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Many other improvements have been made on the five DH Models, adding to the quality and performance of Dean Hill Horizontal Turbines. A new catalog completely describes these models, and this information will be sent you on request.

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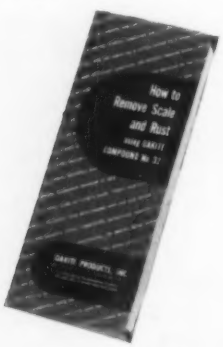

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CARBIDE & CARBON

Continued from page 230

control room through geared electric motors. In addition, every bearing temperature in the plant is supervised by an electrical alarm system that sounds a warning and identifies overheated bearings. Further plant protection is provided by an annunciator that notifies the operator of abnormal pressures, temperatures and levels.

Operation. Showing more than the usual amount of ingenuity, C&C engineers were able to iron out all difficulties that appeared during the shakedown period. When it was discovered that the boiler settings were not pressure tight, an electronic leak detector was used in conjunction with the admission of Freon gas to the casing. This setup detected leaks of such low order that it had to be desensitized.

Metering continuous blowdown proved something of a problem at first. Pressure drop across the flow nozzle in the line between boiler and flash tank produced enough flashing to make the resulting differential useless for metering purposes. First ideas to improve this situation were to cool the line and drop the nozzle to a point where static head equaled the pressure drop across the nozzle. When this solution proved impracticable, the flow nozzle was moved to the outlet of the blowdown heat exchanger. Correction factors were applied to make the meter read directly in blowdown water.

Operating results show that the use of high-solids feedwater at 1000-psi boiler pressure has introduced no complications. The plant has run through the worst weather of the annual cycle without effect on service continuity or discomfort to operating personnel. All expected cost savings have been realized and further installations of similar design are under construction or in the planning stage.

WATER TREATMENT

Continued from page 101

residual can cause rapid delignification even though the sodium carbonate and pH values are reasonable.

Painting is probably the best surface treatment for delignification. Either a cement-base or aluminum paint is satisfactory. Impregnating tower wood with oil increases the fire hazard and endangers tower performance because the slightest amount of oil in the circulating water forms a surface film retarding evaporation. Impregnation of tower wood with water-soluble compounds is hardly worthwhile because

the V·I·P

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New diesels get same "lube diet" that kept old units healthy...

For many years, the Las Animas Municipal Power and Light Company kept its original diesel equipment operating at remarkably low cost. Using Standard diesel oils, down time and maintenance were negligible in spite of greatly increased loads that forced the units far beyond their rated capacities.

In 1951, when two new 1750 hp. Nordbergs were installed in the Las Animas, Colorado, power plant, it was natural for plant officials to select STANDARD HD Diesel Oil on the basis of this outstanding past performance.

Used exclusively in the new units, STANDARD HD has set a new high for healthy performance. In over two years of continuous hard service, STANDARD HD has supplied clean, protective lubrication. After 6000 hours of operation wear was so slight that it could not be measured; engines are kept clean constantly in all working parts.

STANDARD HD
TRADE MARK
OIL

• Diesel plant operators throughout the Midwest have discovered they can count on low cost diesel operation when they use STANDARD HD Oil. STANDARD HD provides an economical solution for costly maintenance problems—ring sticking and breaking, carbon deposits, cylinder wear—because STANDARD HD Oil lubricates, cleans *and* protects.

A Standard Oil lubrication specialist stationed near your plant throughout the Midwest can help you secure successful results in the operation and maintenance of your diesels. For his services, call your local Standard Oil Company office. Or write: Standard Oil Company (Indiana), 910 S. Michigan Avenue, Chicago 80, Illinois.

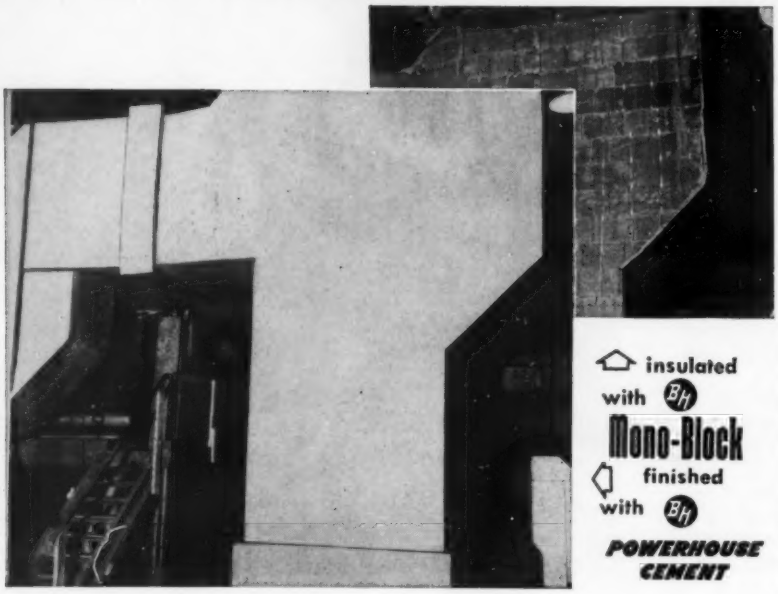
STANDARD OIL COMPANY
(Indiana)

STANDARD

Ralph Barbee, plant superintendent of the Las Animas Municipal Power and Light Company, checks the operating log with E. C. Jeffries, Standard Oil lubrication specialist.

looking in..

Power for ideas?



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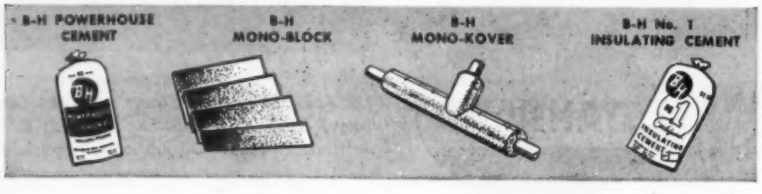


WATER TREATMENT

Continued from page 232

they leach out into the circulating water and are lost by blowdown.

Corrosion. Treating cooling-tower water increases the importance of the corrosion problem. To control delignification and scale, the pH of the water must be lowered. This tends to increase the possibility of corrosion. Higher pH means the water is less corrosive and some scale is advantageous because it provides a protective film.

Corrosion in cooling towers results from dissolved oxygen, carbon dioxide, nitrates, chlorides or low pH. Some corrosion may result from electrolysis by voltaic couples. But low pH and dissolved oxygen are the most common causes.

Either direct chemical reaction or passivators may be used for corrosion control. Chemical control usually consists of increasing the pH and is unsuitable for cooling towers. Passivators form a protective film to prevent corrosion of tower parts. Common passivators include chromates, silicates, phosphates, chromglucosates, glucosides and sodium-sulfoglucosates.

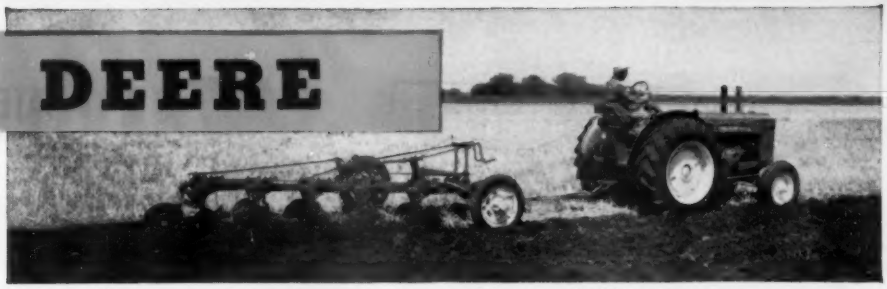
Most passivators require close pH control, except chromglucosate, which provides good protection throughout the pH range of 6 to 12. An average residual for this passivator is 100 ppm, though it will vary with the oxygen, carbon dioxide and hydrogen sulfide content.

Favorable results in control of corrosion due to chlorides is obtained with sodium chromate in quantities between 22 ppm and 10 ppm residual. Continually adding chromates to makeup water increases their concentration, depending on percentage rate of makeup and blowdown. During the first one to three months the chromate consumption will be high. This is caused by the need for enough chromate to form a complete coating on metal parts. Excess chromates do not appear to have harmful effects and many operators simply add large quantities once every six months.

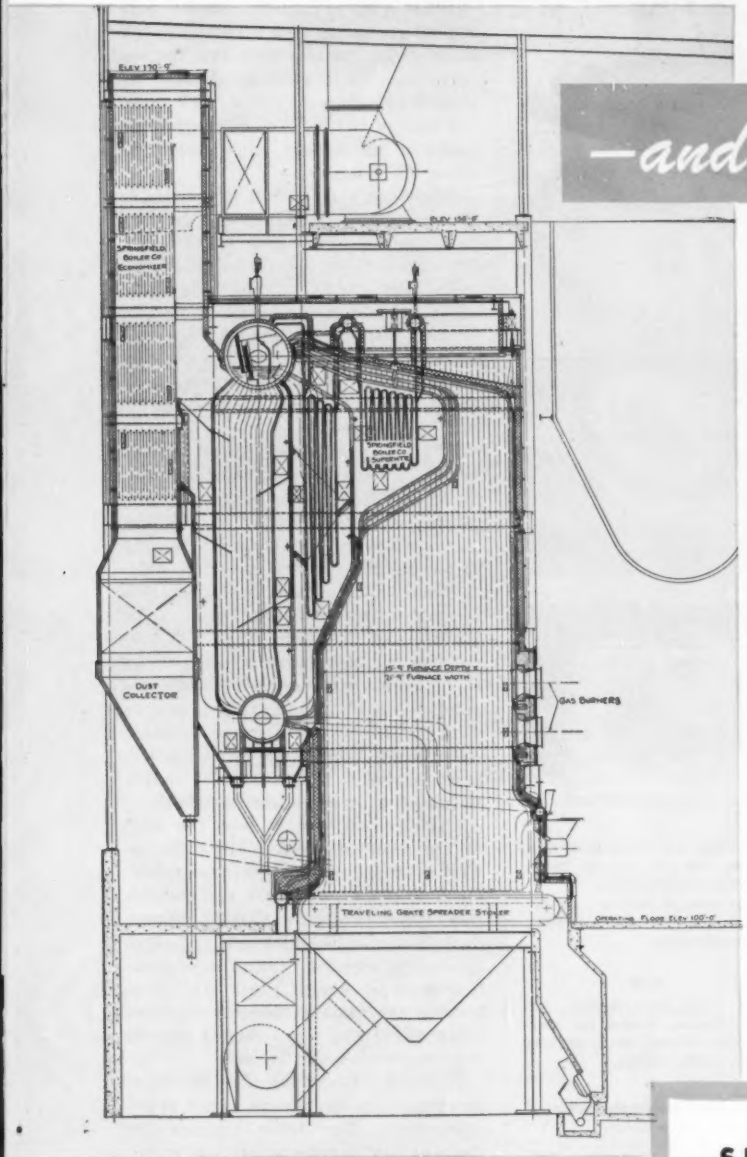
Bacteria play an important part in corrosion. Some organisms reduce the sulfates in water and liberate hydrogen sulfide, which corrodes iron rapidly. Other organisms are iron-consuming. Many treatments are used to prevent this type of corrosive action. Some are 0.5-ppm residual chlorine, lime-soda treatment and the compound chlorine-ammonia. In any case, this type of corrosion is prevented by steps taken for slime and algae control.

Algae and Slime. Untreated cooling-tower water soon shows signs of bacterial and plant growths. Bacterial

JOHN DEERE



John Deere No. 77 Truss Frame Plow drawn by John Deere Model "R" Diesel Tractor



—and SPRINGFIELD

28 Boilers in 28 Years

"We have purchased twenty-eight boilers from Springfield Boiler Co. during the past twenty-eight years. The first boiler, as I recall, was for the John Deere Malleable Works in East Moline," writes S. A. Nelson, Supervisor of Plant Engineering for Deere & Company, Moline, Illinois. With manufacturing plants located across the country, Mr. Nelson has had opportunity to study boiler operation and efficiency under widely varying conditions. The latest *repeat order* for a Springfield-built unit is a 185,000 lb. high pressure steam generator (*left*) recently placed in service at one of the company's large midwestern factories.

Handling *repeat orders* is an important part of Springfield's business. It comes from the *plus values* Springfield gives in (1) ENGINEERING DESIGN, (2) SHOP FABRICATION, and (3) FIELD ERECTION—values that result in superior performance, less maintenance, greater lifetime economy.

Find out about the broad range of service SPRINGFIELD offers—from small, standardized PACKAGE BOILERS to large, specially designed STEAM GENERATING UNITS. *Your inquiry will receive prompt attention.*

NEW INSTALLATION
at a midwestern John Deere plant

Continuous Steam Capacity	185,000 lb/hr.
Maximum Steam Capacity, 2-hr. peak	204,000 lb/hr.
Boiler Design Pressure	925 psig
Operating Pressure, at Superheater Outlet	850 psig
Final Steam Temperature	835°F.
Feedwater Temperature	230°F.
Type of Firing	Spreader Stoker (future gas)
Furnace Width	21'-9"
Furnace Depth	15'-9"

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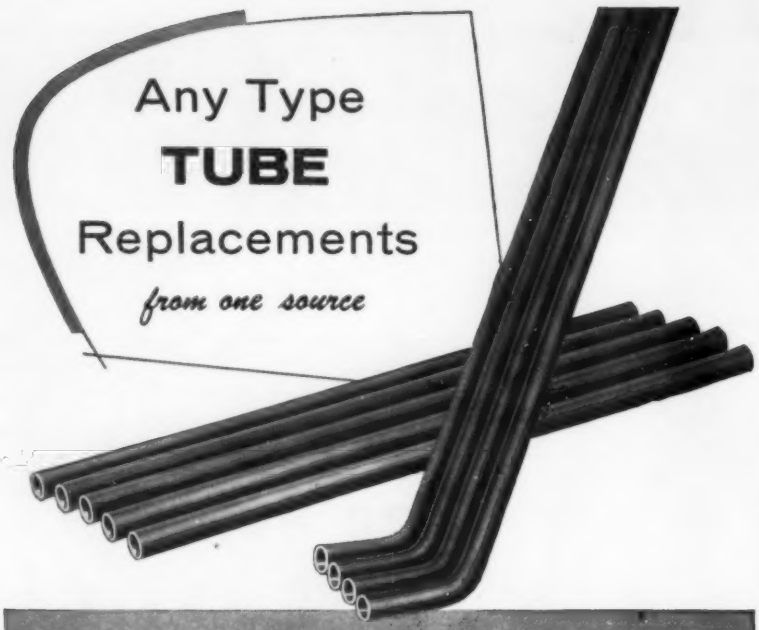

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WATER TREATMENT

Continued from page 234

growth is visible in the form of slime. Many varieties possess a cellulose membrane like higher plant life. This membrane forms a gelatinous film on the warm surfaces of heat exchangers. Film collects sand and other solids, forming a slime scale that reduces heat transfer.

Other types of bacteria combine with any oil present to form a tough, spongy scale. Some combine with iron, causing corrosion. Their presence is often indicated by a fishy odor or a black slime, but more often they can be detected only under a microscope when magnified about 900 times.

Algae are higher plant life visible to the naked eye. Usually green, they can be of various colors. Requiring sunlight for growth, they are found mainly in open distributing systems, flumes and other exposed wet surfaces. Principal harm is disturbance of air and water patterns and clogging of pipes and nozzles. Because of their color variation, algae may be difficult to recognize in their early stages.

Chlorine, chloramine, copper sulfate, bromine, hyperchlorite solutions, potassium permanganate, quaternary ammonia compounds, cupric chromglucosate and many other chemicals are used to control algae and slime.

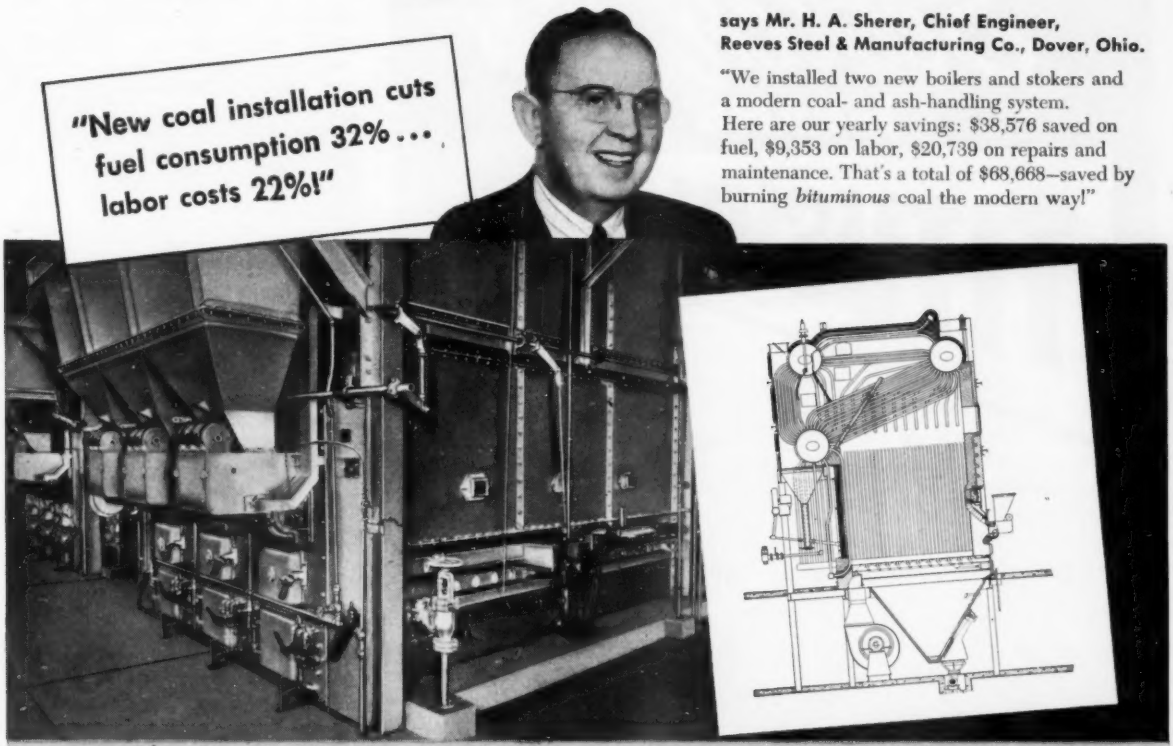
Quantity of chemical added is not a function of makeup water, as it is for scale control. Chlorine, bromine, hyperchlorite and chloramine are affected by some organic and inorganic matters and react with them, reducing the ppm residual. Indirectly this ties the required quantities to makeup rate, but the dosage is usually determined by simply maintaining an established residual.

Chlorine has perhaps been the most widely used algaecide. Much equipment is needed to handle chlorine safely, but it is simple to operate and trouble-free. Experience shows that 2 ppm residual chlorine kills all bacteria and algae in cooling circuits. Initial concentration may be several times this value because the reaction between chlorine being added and any ammonia present reduces chlorine effectiveness.

High pH reduces the effect of chlorine, but not to as great an extent as for chloramine. The latter requires six times as long to react at pH 8 as at 6.5. Lab tests show that sodium hypochlorite in concentrations of 10 ppm chlorine kill all algae in about 6 hours. Chlorine, chloramine and hypochlorite appear to be about equivalent as algaecides.

Concentrations of other algaecides that appear to give satisfactory results are 2 to 5 lb of potassium permanganate per million gallons of water, 1 ppm copper sulfate (some species require 10 ppm), 0.4 ppm liquid bromine. Sodium

"WE SAVE OVER $68,000 A YEAR— BY BURNING COAL THE MODERN WAY!"



says Mr. H. A. Sherer, Chief Engineer, Reeves Steel & Manufacturing Co., Dover, Ohio.

"We installed two new boilers and stokers and a modern coal- and ash-handling system. Here are our yearly savings: $38,576 saved on fuel, $9,353 on labor, $20,739 on repairs and maintenance. That's a total of $68,668—saved by burning *bituminous* coal the modern way!"

A view of the plant's firing aisle and a diagrammatic drawing of one of the boilers. It now costs 18.8¢ less to generate every thousand lbs. of steam. This is a saving large enough to amortize the entire installation in 3 years-3 months. And that includes all the cost incurred in tearing out old equipment and constructing a new plant floor!

● Today, *bituminous* coal's inherent economy has been greatly increased. Modern combustion installations give you more steam for every dollar . . . automatic coal- and ash-handling systems cut labor costs to a minimum.

A consulting engineer can show you how coal can do a better job—*and save you real money*—in a plant designed to meet your *specific* needs.

In addition, with coal you get the basic advantages of price stability, and dependable supply. These advantages are assured by America's virtually inexhaustible coal reserves and the high productivity of America's coal industry.

If you operate a steam plant, you can't afford to ignore these facts!

COAL in most places is today's lowest cost fuel.

COAL resources in America are adequate for all needs—*for hundreds of years to come.*

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

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THE TITUSVILLE IRON WORKS COMPANY
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Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement

WATER TREATMENT

Continued from page 236

pentachloride shows favorable results as an algaecide.

Algaecides lose their effectiveness after short periods because the algae build up an immunity. So larger charges must be added about once a month for short periods. Overcharging must be avoided because it is thought high concentration of many algaecides is harmful to redwood.

Quaternary ammonium compounds and cupric chromglucosate are two other algaecides finding some use today. Both require care in their use.

MAINTENANCE PROGRAM

Continued from page 107

must be gained by actual contact during initial assembly of the machine and any subsequent inspections. Plant maintenance men should be present during initial erection of a turbine-generator.

Remove the generator rotor to permit close inspection of coils, wedges and binding, and condition of windings. If dirty, clean the windings, and if it appears advisable, apply insulating varnish. Check pedestal insulation on collector ring end of machine to insure against deterioration of generator bearings from electrolysis. If necessary, recondition collector rings and exciter commutator surfaces, and fit in new brushes.

Carefully inspect condenser and auxiliaries for wear and leaks. Support condenser properly to prevent undue strains on the turbine while filling the condenser with water for test.

Slime coating on condenser tubes will sometimes crack off if the water side of the condenser is left to dry. This practice may be undesirable, however, if packing is used on tube ends. Dry-out of packing may cause leaks.

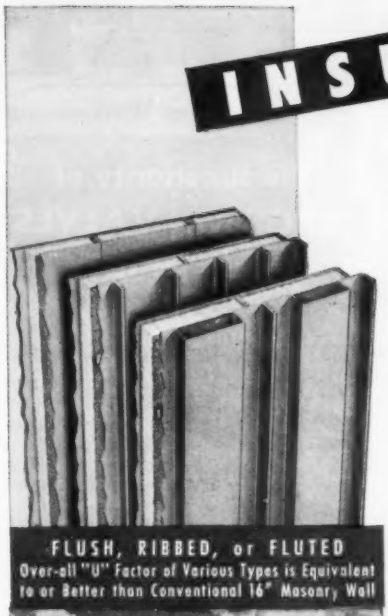
In stations where more than one boiler serves each steam-supply header, inspection and maintenance can be handled on a regular production basis without excessive efforts to save outage time. But with a single boiler per turbine arrangement without interconnection with adjacent units, boiler outage reduces possible electrical output from plant. This usually justifies a closely coordinated inspection and cleaning schedule with overtime work to reduce outage time. Maintenance for duplicate boiler auxiliaries is usually scheduled for a time other than that for the main boiler.

Remove inspection plates and housings while the boiler is cooling. Place scaffolds, lights, tools and equipment close at hand, ready for use as soon as it

INSULATED METAL WALLS

for POWER and STEAM GENERATING PLANTS

ALUMINUM, STAINLESS or GALVANIZED STEEL



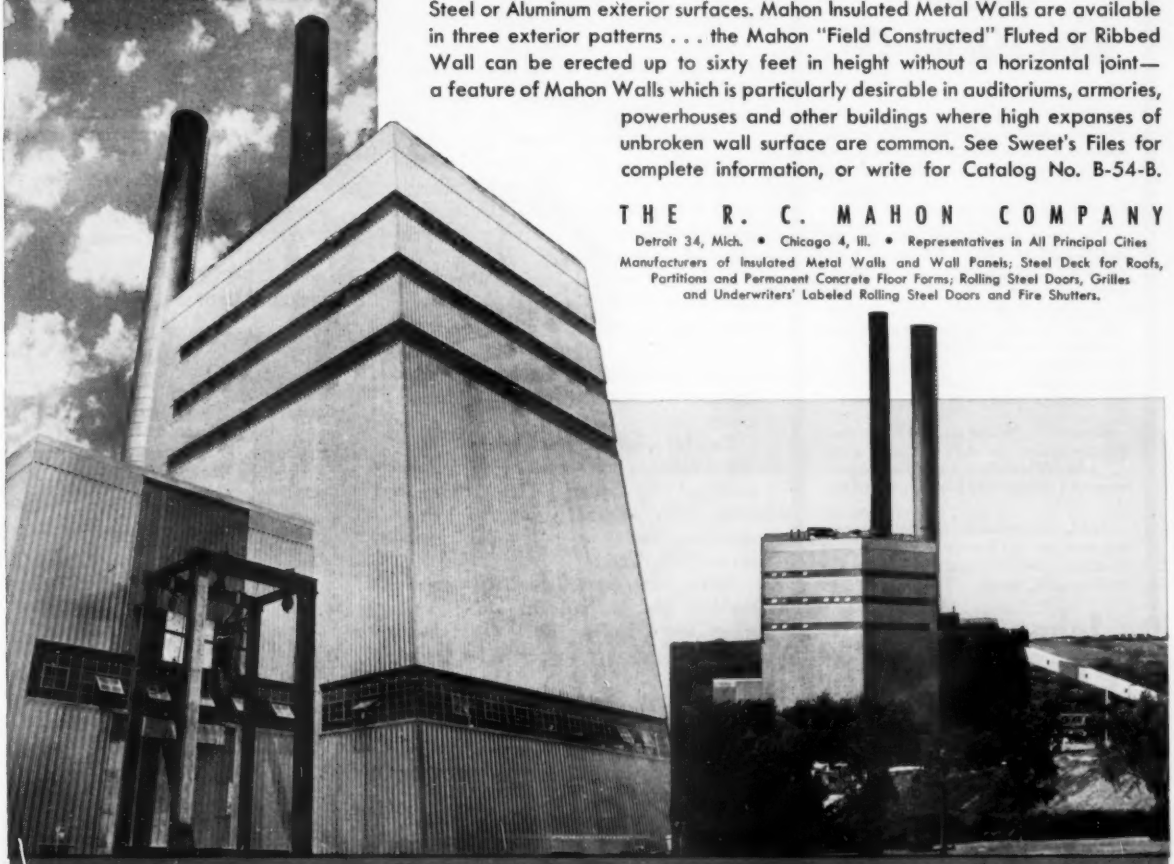
FLUSH, RIBBED, or FLUTED
Over-all "U" Factor of Various Types is Equivalent to or Better than Conventional 16" Masonry Wall

Below is illustrated an addition to a power generating plant in which Mahon Aluminum Insulated Walls were employed for all exterior surfaces. Both the designers and the power company are enthusiastic about the over-all appearance of the completed structure. The advantages of Insulated Metal Walls, however, are not confined to appearance and design effects obtainable . . . important building economies are realized through lower material cost, lower labor cost, and the cumulative savings resulting from reduced construction time . . . buildings can be quickly enclosed with Insulated Metal Walls—even under extreme low temperature conditions which would preclude masonry construction. Other important factors to be considered are the light weight of these modern curtain walls and the maintenance-free permanence of Stainless Steel or Aluminum exterior surfaces. Mahon Insulated Metal Walls are available in three exterior patterns . . . the Mahon "Field Constructed" Fluted or Ribbed Wall can be erected up to sixty feet in height without a horizontal joint—a feature of Mahon Walls which is particularly desirable in auditoriums, armories, powerhouses and other buildings where high expanses of unbroken wall surface are common. See Sweet's Files for complete information, or write for Catalog No. B-54-B.

THE R. C. MAHON COMPANY

Detroit 34, Mich. • Chicago 4, Ill. • Representatives in All Principal Cities

Manufacturers of Insulated Metal Walls and Wall Panels; Steel Deck for Roofs, Partitions and Permanent Concrete Floor Forms; Rolling Steel Doors, Grilles and Underwriters' Labeled Rolling Steel Doors and Fire Shutters.



New addition to Granite Falls Power Station built by Northern States Power Company. 31,000 Sq. Ft. of Mahon Aluminum Insulated Metal Wall were employed in Exterior Surfaces. Pioneer Service & Engineering Co., Chicago, Ill., Designers.

MAHON

Close-up view of leaf-type filter used with Sorbo-Cel by Pullman-Standard

How Pullman-Standard operates boilers on a

1% blow-down basis...

with SORBO-CEL

At the Haskell & Barker plant of Pullman-Standard Car Mfg. Co., Sorbo-Cel solved the major filtration problem of removing oil from condensate returned to the two new 50,000 lb-per-hr 400 psi, 750-F boilers.

Pre-Coat Sorbo-Cel and regular Sorbo-Cel, specially processed high flow-rate diatomaceous silica powders, are used on leaf-type filters. After a film of Pre-Coat Sorbo-Cel has been built up on the filter screens, regular Sorbo-Cel is added continuously to the unfiltered water. This means a new filter surface is constantly presented to the oncoming water.

Results . . . Water filtered by Sorbo-Cel contained less than 0.1 ppm of oil . . . and boilers have since been operated on a *one per cent* blow-down basis.

Send coupon below for bulletin giving data on this low-cost way to remove oil from water. No cost or obligation.

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MAINTENANCE PROGRAM

Continued from page 238

is safe to enter the boiler and furnace.

You can safely expedite cooling by running fans to speed up air flow through the unit. A temperature drop of 30 to 50 F per hour, shown by steam pressure, temperature of drum metal or temperature of gas leaving boiler is usually permissible. When pressure reaches atmospheric, drain boiler water.

Tag all valves and connections to assure safety of men in a boiler, then carefully inspect pressure parts internally and externally. Inspect furnace, brickwork, baffles and burners or stokers, and make required repairs.

Wash down the inside of the boiler and, if necessary, turbine the tubes. In any case, turbine a few sample tubes, to determine if there is any serious deposition of scale. Acid-cleaning a boiler may be advisable in certain situations.

Note condition of superheater elements and supports, and make needed repairs. Inspect safety valves, regrinding if necessary. Take care to return them as closely as possible to original settings. Inspect and clean all other valves and connecting piping.

Clean, inspect and repair the breechings and dust collectors. Check fans for mechanical condition. Wear on induced-draft fan parts may require rebuilding and rebalancing or complete replacement of some parts.

Make major coal- and ash-handling equipment repairs during the boiler outage if this cannot be done during regular operation. Clean and calibrate gages, instruments and control equipment, and inspect instrument piping and connections.

Careful scheduling will prevent interference among men working on various parts of the boiler. When it is all cleaned, an internal inspection by insurance-company or state boiler inspector is in order.

After complete internal inspection, replace gaskets and fill boiler with water for a hydrostatic test at about operating pressure to check for leaks. Boiler inspector ordinarily wants to witness this test. Gag safety valves, or use some other means to insure that pressure doesn't rise enough to open valves, as water may damage them if they open under pressure.

When everything has been put back to normal, and proper persons have removed all hold tags or clearances, fire up the unit in the usual manner. On large units a man should stand by to tighten handhole and manhole gaskets and check on adjustments of safety valves, instruments and controls.

Most other plant equipment may be

Sound Design

Quality Materials

Precision Workmanship

the superiority of JERGUSON VALVES speaks for itself

OS&Y Valves for severe conditions

Rugged Jerguson OS&Y Valves are the ideal answer to meet high temperature or corrosive conditions where inside threads can't be tolerated. Efficient outside thread design eliminates possible freezing and allows the valve stem to work freely at all times.

GA Valves for instrument piping and general use

Tremendous time and cost savings are possible with Jerguson GA Valves. Threaded connections can be reduced from 10 to 3 . . . unions, nipples, reducers, elbows, tees, valve, and bleed valve are combined in one space saving unit.

Jacketed Heated-Cooled Valves

Designed especially for use with heated or cooled gages, Jerguson No. 93 Valves have a surrounding jacket for circulating the heating or cooling medium. They give safe, dependable, leak-tight service.

Globe Valves

Jerguson Globe Valves, furnished in ¼, ½, and ¾ inch sizes with renewable, regrindable seats. Can be furnished with Stellited stem and/or OS&Y.

All valves shown rated at 3000 lbs. @ 500°F. Send for detailed Data Units . . . or outline your requirements and let Jerguson engineers go to work for you.

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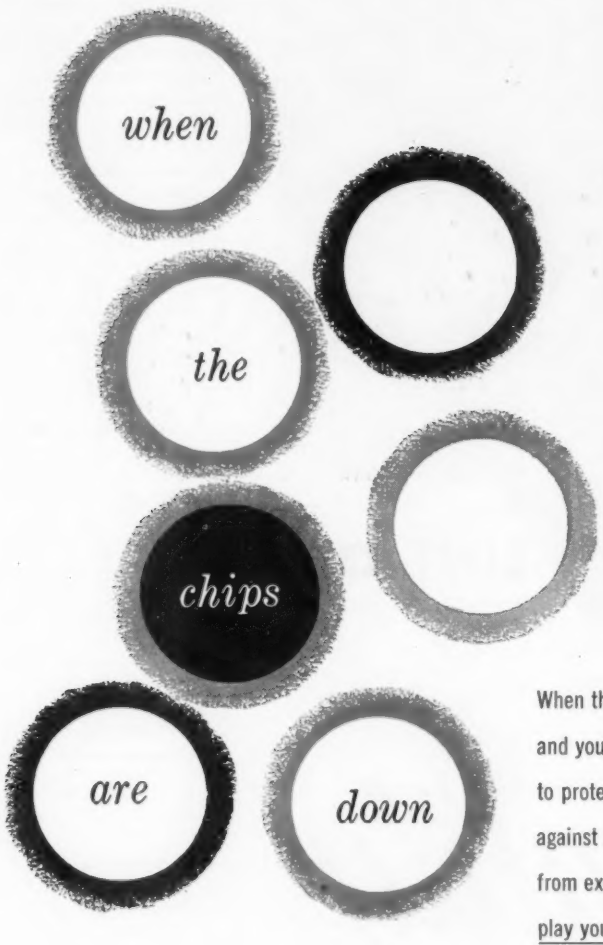

When the chips are down
and you must hold a winning hand
to protect expensive piping and equipment
against stress and strain
from expansion and contraction—
play your ace!
Count on Zallea Duo-Equalizing Expansion Joints.
Their life expectancy has been proven
40% to 1800% better than any self equalizing—
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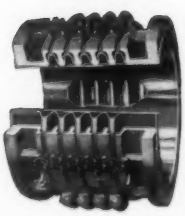
So specify—and insist on Zallea!



Zallea already has, or will make, expansion joints for every service. For information on standard types, request Bulletin 351.

For consultation on special problems, ask us to have our representative call.

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expansion joints

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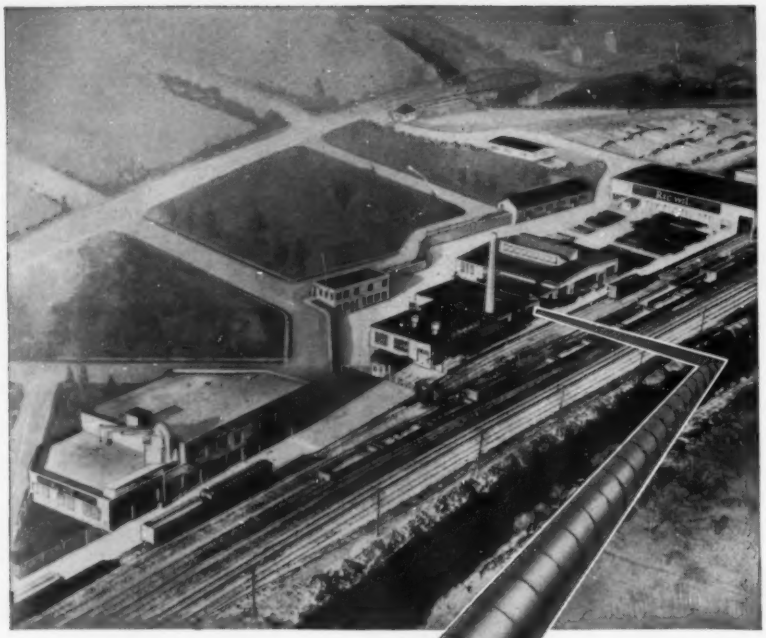
World's Largest Manufacturers of Expansion Joints



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THE RIC-WIL COMPANY
BARBERTON, OHIO

MAINTENANCE PROGRAM

Continued from page 240

inspected and overhauled while the main units are running. But be sure all items that cannot be handled safely during operations are overhauled or inspected during outage of the main unit.

Maintenance Records. Ordinarily the usual time and material purchase records and regular accounting department figures keep track of cost of maintaining major portions of the plant. But companies vary in practice of recording more detailed maintenance costs.

Some companies keep costs for all work done on each unit or subunit of equipment, while others keep no costs beyond minimum accounting records. A middle-of-the-road course keeps major subdivisions of costs for groups of similar equipment on a monthly or yearly basis.

A history record file for each piece of equipment is very helpful. It gives briefly dates, work done, dimensions taken during overhaul or repair adjustment or settings made, etc. This requires filling out a report form for each maintenance job. Essential information is then copied on the record sheet in chronological order. Top of the record sheet should list manufacturer, serial number, sizing and other details.

MARMADUKE

Continued from page 152

everything they could lay their hands on—just like a lot of jittery kids.

"It wasn't exactly warm in that boiler room, and suddenly I felt a gale blowing through it. As I looked around to see where it was coming from, an important-looking guy came storming in, yelling his lungs out. But all his hollering just confused his men still more, because he wasn't putting them on the right course.

"'Why don't you try closing your big mouth and using your head?' I finally blasted at him over all that noise. Although I just wanted to help out without hurting his feelings, my voice stopped the works. I was noticed for the first time and everyone crowded around to see what I was up to. Even the safeties stopped popping just then.

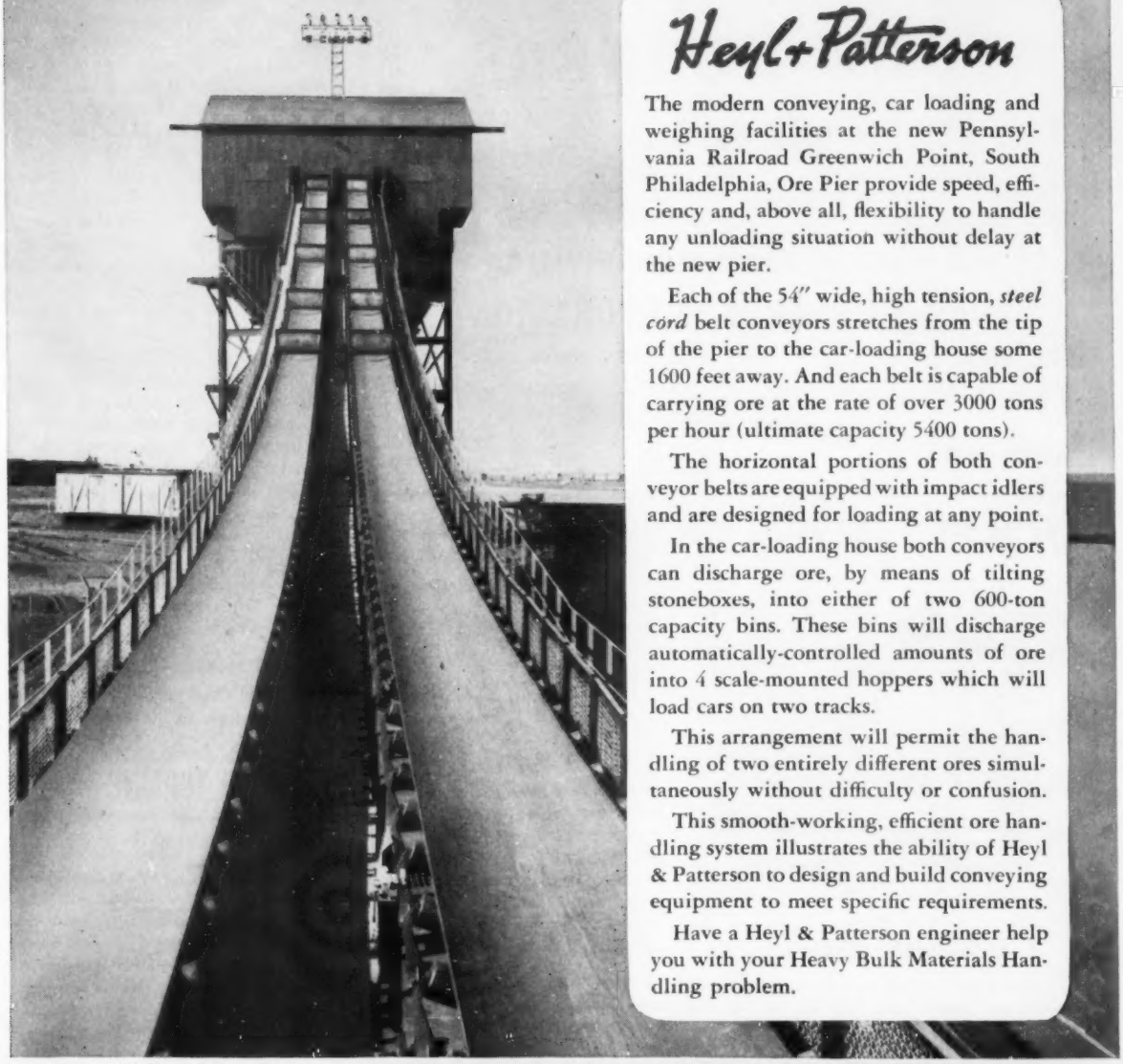
"The boss sized me up for a second, then said, 'When I want a tramp's advice, I'll ask for it—Say!—Who in the hell are you and how'd you get in here in the first place?'

"'That's a fair question,' I answered with my teeth chattering just a little. I've straightened out more power plants ashore and afloat by using my head than you have by popping off. But right now I'm scraping bottom, so, if you'll blow me to some chow and sign me on

At Pennsylvania Railroad's New Ore Pier

Super Highway for Ore

Designed, Fabricated and Erected by



Heyl+Patterson

The modern conveying, car loading and weighing facilities at the new Pennsylvania Railroad Greenwich Point, South Philadelphia, Ore Pier provide speed, efficiency and, above all, flexibility to handle any unloading situation without delay at the new pier.

Each of the 54" wide, high tension, *steel cord* belt conveyors stretches from the tip of the pier to the car-loading house some 1600 feet away. And each belt is capable of carrying ore at the rate of over 3000 tons per hour (ultimate capacity 5400 tons).

The horizontal portions of both conveyor belts are equipped with impact idlers and are designed for loading at any point.

In the car-loading house both conveyors can discharge ore, by means of tilting stoneboxes, into either of two 600-ton capacity bins. These bins will discharge automatically-controlled amounts of ore into 4 scale-mounted hoppers which will load cars on two tracks.

This arrangement will permit the handling of two entirely different ores simultaneously without difficulty or confusion.

This smooth-working, efficient ore handling system illustrates the ability of Heyl & Patterson to design and build conveying equipment to meet specific requirements.

Have a Heyl & Patterson engineer help you with your Heavy Bulk Materials Handling problem.

High Lift-Turnover-Rotary Railroad Car Dumpers
Boat Loaders and Unloaders
Ore Bridges
Coal Handling Equipment
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Heyl+Patterson, Inc.

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55 FORT PITT BLVD. PITTSBURGH 22, PA.

EXTRA YEARS OR MORE DEPENDABLE POWER

. . . at less cost per pound of steam

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COMBUSTION EQUIPMENT DIVISION

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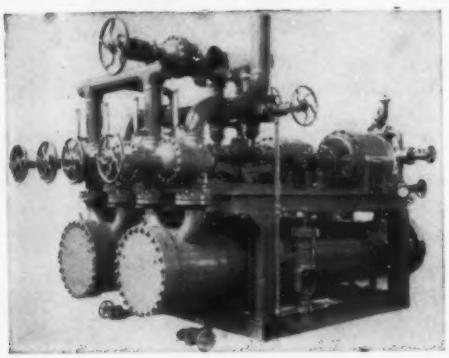
LOCKETT FUEL OIL PUMPING AND HEATING SETS



The compact, high-pressure Unit illustrated here was built for a large Utility Station in the South West. It consists of two Motor-driven Pumps and two Shell - and - tube - type Oil Heaters mounted on a single frame. Each pump is designed to handle a capacity of 55,000 pounds per hour of bunker fuel oil, against 300 P.S.I.

Custom Built

For almost a half century, Lockett has been supplying, to fit individual needs, efficient standard and custom-built, Fuel Oil Pumping and Heating Sets, for mechanical and steam atomizing oil burners. Combinations of various types of pumps are available: Either two Turbine-driven Pumps; one Electric-driven and one Turbine-driven Rotary Pump; two Electric-driven Rotary Pumps; two Worthington Duplex Steam Pumps; or one Duplex Steam Pump and one Electric-driven Pump. Each pump-and-heater is suitable for the full rated capacity of the unit; the second pump and heater are spares. Lockett supplies everything, complete. Inquiries are invited. *Descriptive bulletins sent on request.*

A. M. LOCKETT & COMPANY, LTD.

Contracting Mechanical Engineers

NEW ORLEANS - HOUSTON - DALLAS - GALVESTON

MARMADUKE

Continued from page 242

the articles for a short voyage, I'll have your plant back on automatic inside of ten minutes.'

"That crack turned on his—and everyone else's—running lights.

" 'It's a deal,' the boss finally said, 'but just the same, I think you're cracked.'

" 'Look here,' I began. 'I can see you fellows don't know anything about automatic combustion controls. You think just because your equipment is automatic, it'll run your plant for you. But machinery has to be in operating condition just like a human being.'

" 'Cut out the song and dance, stranger,' the boss yelled. 'Just get to the point.'

" 'When I came in here,' I continued, 'I couldn't move my arms until I thawed them out. And that's all that's wrong with your controls. See that open window there?' I pointed above the boilers. 'Well, close it. Then get a blow torch and thaw out that line from the steam header to the master bellows. And after you thaw it out, be sure to insulate it if you're going to keep this boiler room at sheep car temperature, and still expect this automatic equipment to work.'

"That advice struck home like a steam hammer. Without anyone saying a word, one guy ran for the ladder while another dug up a torch. After a few minutes, the plant was back on automatic.

"The boss turned out to be a good skate," Marmy wound up as he reached for the coffee pot. "He took me across the street to the diner and drank coffee and smoked while I washed down half a dozen fried eggs and a few pork chops with a pot of black coffee."

—*SME*

VERSATILE TURBINE

Continued from page 105

in. Hg vacuum. When the electrical load is so low that no steam flows to the multistage section (total extraction operation), a bypass valve permits it to receive a small amount of cooling steam.

During the nonprocess season the multistage turbine receives steam from the 400-psi boiler and operates on a condensing cycle. No steam flows through the single-stage turbine. To reduce windage losses a bypass connection between the extraction zone of the cylinder and the exhaust opens automatically, subjecting the single-stage chamber to exhaust vacuum.

Controls. The turbine-control system includes a transfer valve with two positions. During the nonprocess season the transfer valve forces the steam-chest

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The control gage board for Astoria's No. 10 boiler. At top: Hays Model WSF for mounting above eye level. Right center: Hays Model WCF8P for eye level. Four mounting styles are available to meet special requirements.

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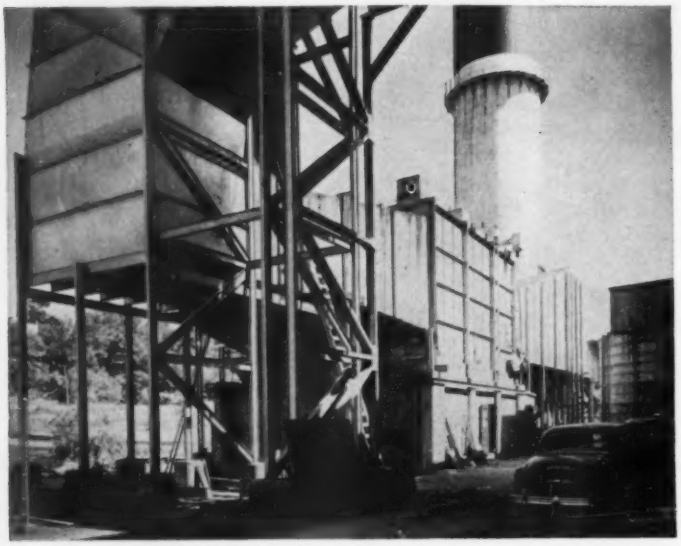

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VERSATILE TURBINE

Continued from page 244

valves of the single-stage section on their seats, keeping them closed. Valves of the multistage section operate normally to increase or decrease steam flow as the electrical load requires. For the process operation the transfer valve is placed in its other position, permitting the single-stage section to function as a noncondensing turbine with backpressure regulation, while the multistage section operates on a condensing cycle.

Although the application is unique, the unit was assembled from standard components. Both the process and nonprocess cycles give efficient, economical operation throughout the year.

COAL GAS-TURBINE

Continued from page 95

should be precision cast from S-590, while rotor blades should be machined from 19-9DL. Re-assembly of the turbine has been done by Alco personnel under direction of LDC staff.

A number of minor but significant dimensional changes were found as reassembly proceeded and these were discussed with Allis-Chalmers turbine engineers. Because of the high operating temperature of the turbine (1300 F) and the high coefficient of thermal expansion of the various kinds of stainless steel used in its construction, extreme care has been taken to provide and maintain adequate clearances. Expansion of various components will be watched carefully when operation resumes.

Test-Plant Alterations. Only major change in turbine test plant is elimination of the regenerator. This is expected to increase full-load output by some 300 hp, at the expense of a 500-lb-per-hr increase in coal rate. Inspection of turbine blading will be greatly facilitated. Value of a regenerator for locomotive service with low-cost fuels depends largely on reducing its first cost and maintenance expense to a very low figure. Since the performance of the plant with a regenerator has been determined, the Operations Committee decided to see how it will do without a regenerator.

1954 Program. The 750-hr test showed that the LDC turbine could carry full load and run as smoothly on coal as on oil. The coal feeding and pumping equipment did an adequate job and the combustors functioned satisfactorily. The flyash separation equipment didn't measure up to requirements and excessive blade erosion took place. The forthcoming test program will aim primarily at learning whether the new multitube separators with Mark III

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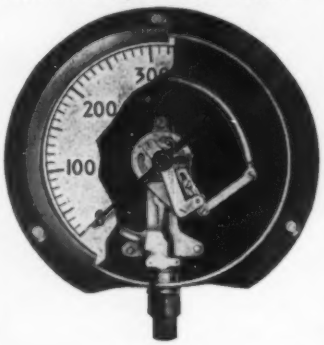

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COAL GAS-TURBINE

Continued from page 246

Dunlab tubes can give adequate protection to the turbine blades.

The 1954 test program will begin with calibration of the new multitube separators. After the plant has been checked out and the necessary expansion readings have been taken, a test will be run with flyash of known characteristics being fed through the burners into the combustors. The ash will be fed from weigh-tank and coal pump formerly used with the Houdry unit.

A single Mark III Dunlab tube has already been tested with similar ash on separator test stand. Performance of complete separator system will be checked by comparing weight of ash caught with amount fed into system and, also, by collecting ash samples from separator inlets and outlets.

Next turbine test period has been set tentatively at 250 hr with daily runs of 10 to 15 hr. This will be followed by a 500-hr test. Turbine inlet temperature will be held at about 1250 F, with turbine speed set to give at least 3000 shaft hp. Plant performance will be checked at hourly intervals with accurate determinations of compressor air flow, coal consumption and shaft hp. Separator efficiency will be checked by weighing amounts of dust collected at inlet and outlet sampling stations.

Erosiveness of ash entering the turbine will be recorded continuously by the radioactive method. Every precaution will be taken to prevent operation of the turbine under conditions that might cause blade damage. Whenever the turbine is shut down and cooled off, photos of first and last row blading will be taken with a camera equipped with a 60-sec developing attachment.

WIRE-ROPE LUBRICATION

Continued from page 133

This test indicates that lubrication during operation greatly reduces internal friction between component parts of the rope as well as between rope and sheave grooves. Furthermore, by keeping the fiber core in better condition, it helps maintain the support necessary to insure proper movement of the steel strands. These factors automatically reduce the fatiguing action to which a rope is normally subjected when bending over sheaves under tension.

The original lubricant had its maximum effect only up to about 40% of test life (see chart 4). From this point on, broken wires developed more rapidly in the unlubricated ropes, but only moderately so in the lubricated ones.

Conclusions. From these four tests, we concluded that lubrication (1) can

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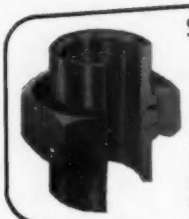

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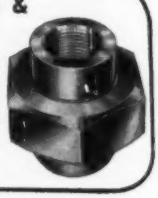

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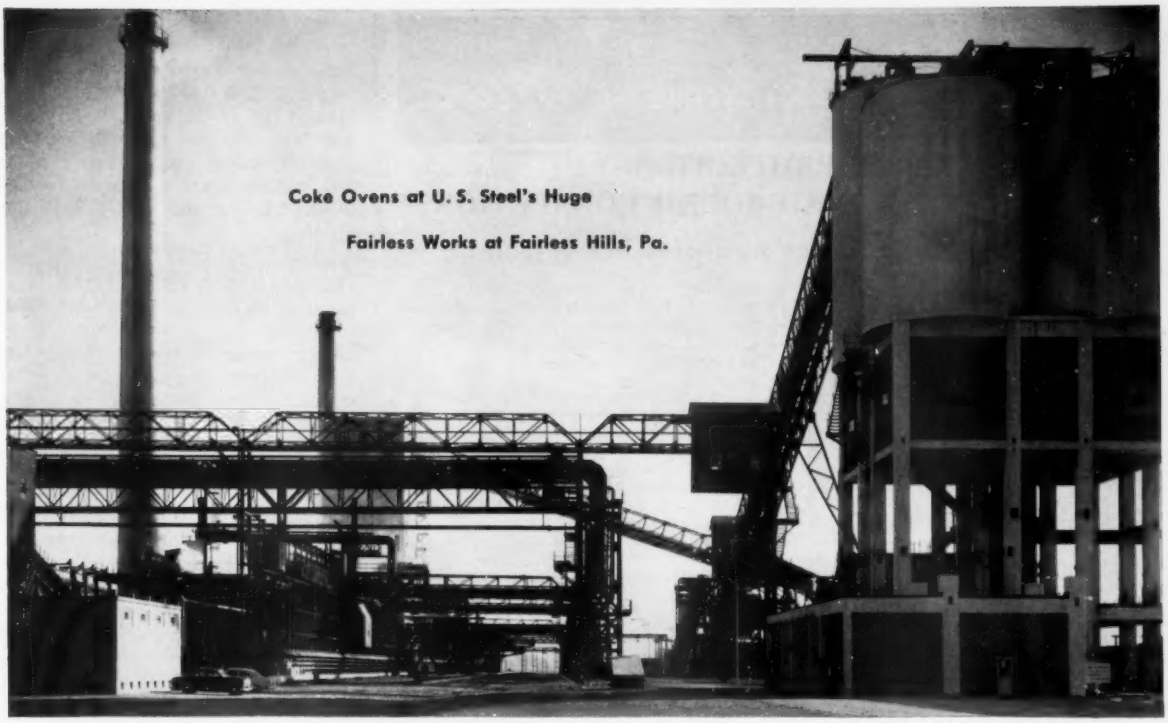

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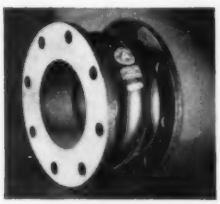

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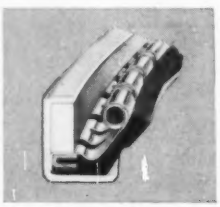

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BIDDLE *Instrument News*

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In spite of apparently good lightning rod or arrester protection, lightning frequently will cause severe damage if high ground resistance hampers its dissipation in the earth. Lightning storms are prevalent in the northeastern states during the spring and fall months. Plants in this section should make a thorough round of ground resistance tests. Aside from the hazards to personnel, thousands of dollars may be saved in damage to electrical equipment and in loss of power and stoppage of production.

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penetrate to the core of the rope (2) preserves fibers longer, helping to maintain the core in good condition so it can afford proper support for the steel strands (3) keeps rope in better condition internally and externally, helping avoid corrosion, and increasing safety (4) reduces friction, retards development of fatigue and adds to rope life.

ADJUSTING COMMUTATION

Continued from page 87

can be seen by comparing values before and after adjustment. Experience has shown whenever brush drop on leading or trailing edge exceeds three volts, destructive commutation results.

Case 2: Motor with strong commutating field. This machine was an old-timer, having been shipped from the factory in 1918, without adequate factory testing. Machine was designed for generator service and later adapted for use as a reversing steel-mill motor.

The machine commutated poorly as a motor. Brushes wore rapidly and commutator developed burned spots. Conventional methods used to improve commutation failed to show up the exact cause of trouble. So brush potentials were taken at 250-300 rpm and 500 rpm. This machine normally operates from 250 to 500 rpm in each direction, making it necessary to record brush potentials corresponding to machine speed and rotation. Selected points are then plotted for the base and top speed.

During normal motoring cycle of load, both base- and top-speed brush-potential plots indicated machine was very strongly adjusted. Similar slopes of curves for each direction of rotation meant brush position was close to electrical neutral. Speed was measured clockwise (cw) and counterclockwise (ccw) directions under similar electrical conditions verifying the neutral setting. Then a shunt resistor was connected across commutating-field circuit to reduce strength of commutating-field flux; brush-potential traces were again taken and tabulated. Brush-potential plots at both speeds showed a decided improvement in adjustment.

After this last change, machine commutation showed an immediate improvement. And after 24 hours little sparking was visible on the pump-back (generating) cycle. A check after six months showed the machine had developed a uniform commutator film with no visible pattern or burned spots. Brush wear showed a decided improvement.

It's important to understand the plotting of pump-back cycle. Where reversal time is extremely short, machine indicates an undercompensated weak adjustment. However, in original adjustments of this machine, excessive com-

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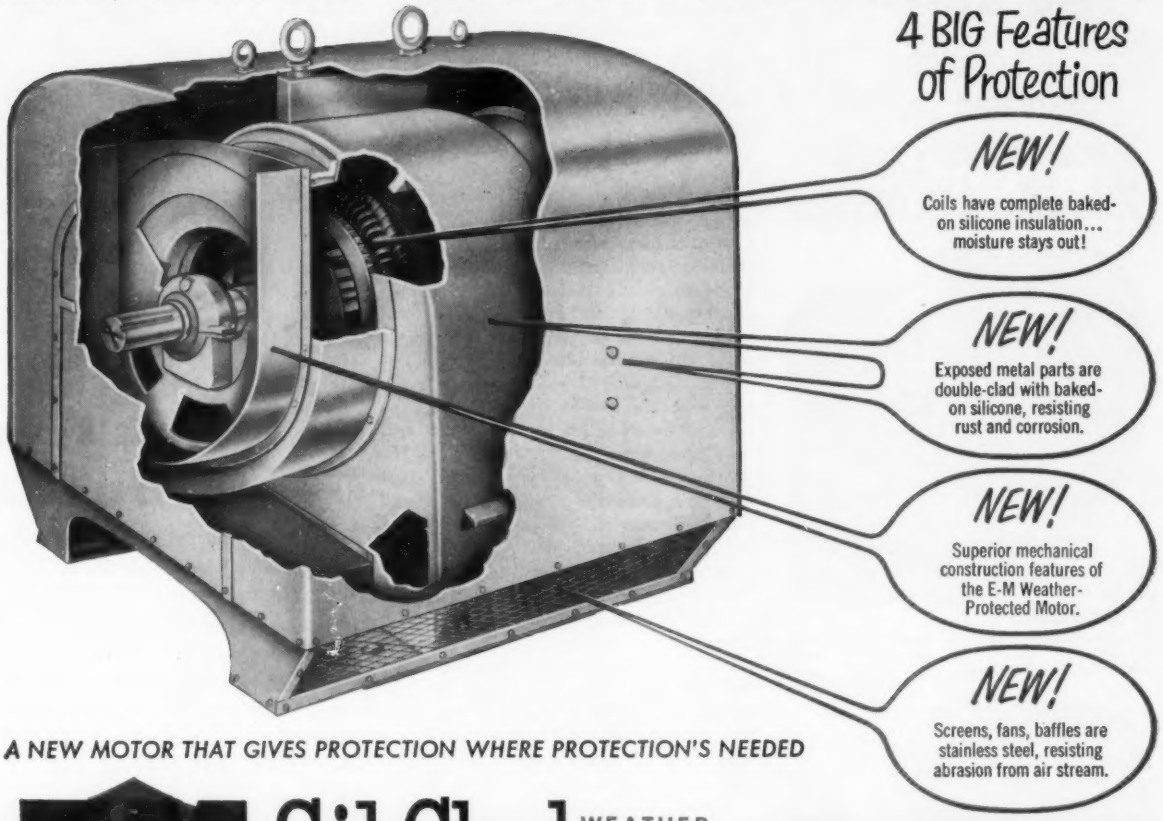
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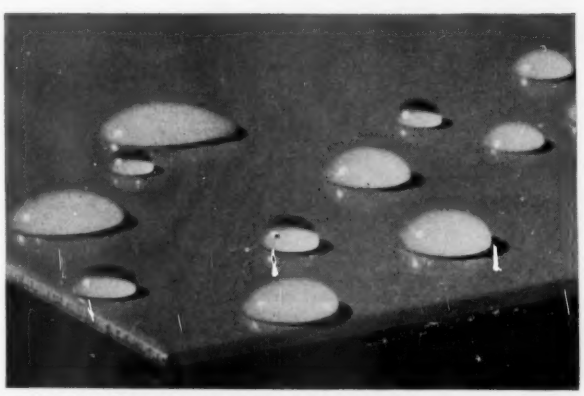

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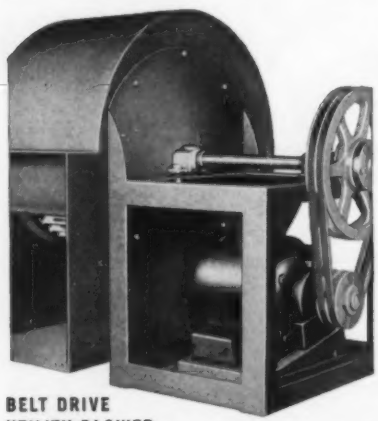

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ADJUSTING COMMUTATION

Continued from page 250

mutating-field strength made brush potentials strong even during pump-back. When adjustment was correct, the pump-back cycle indicated a weak potential. Although these values are weak, remember they are but momentary (see brush-potential traces) and do not shorten brush life. Principal reason for plotting the pump-back cycle is to insure a trailing brush potential not exceeding three or four volts.

Erroneous Data. Preceding two examples of machines out of adjustment are typical of many others having poor commutation performance. Very often, machine operators will attempt shifting brushes without full appreciation of the commutation problem, or will experiment with various brush grades, hoping either method will solve the problem. But with the use of brush potentials, many of the so-called bad actors can be readjusted for satisfactory performance.

When taking brush potentials for the first time, recognize the specific factors that contribute to erroneous data. Use of the brush-potential method is not limited by accuracy of the potential trace but rather by interpretation of results. We find the principal causes for erroneous data are:

1. *Rough commutator:* Brush potentials obtained from a machine with a rough commutator will shift the collection of current toward brush trailing edge. Over-all values will be abnormally high.

2. *Raw commutator:* Data taken on a raw commutator will distribute the current collection across brush faces. Over-all values will be abnormally low.

3. *Light brush pressure:* No apparent change in distribution of a brush potential, with a considerable change in commutating field adjustment or brush shift, usually indicates light brush pressure.

4. *Faulty brush holders:* If brush is not stable in brush box, brush chatter tends to shift collection of current toward trailing edge, similar to that met within a rough commutator.

In a number of cases, we have used the brush-potential method, as described in this article, with complete success. The method has a definite advantage in that commutation tests can be made while machines are running in normal operation, with minimum interference in production schedules. In addition, necessary equipment is portable and can be carried to motor site. However, most significant advantage is its relative simplicity. Often the maintenance engineer can present basic instructions to his assistants and let them carry out the complete job.

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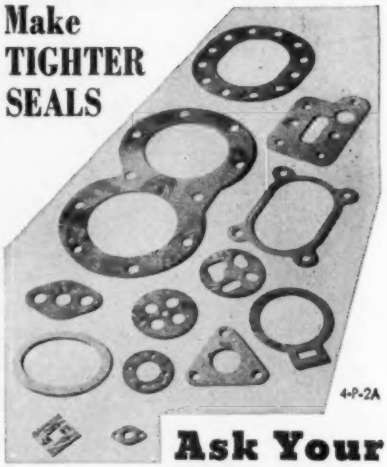

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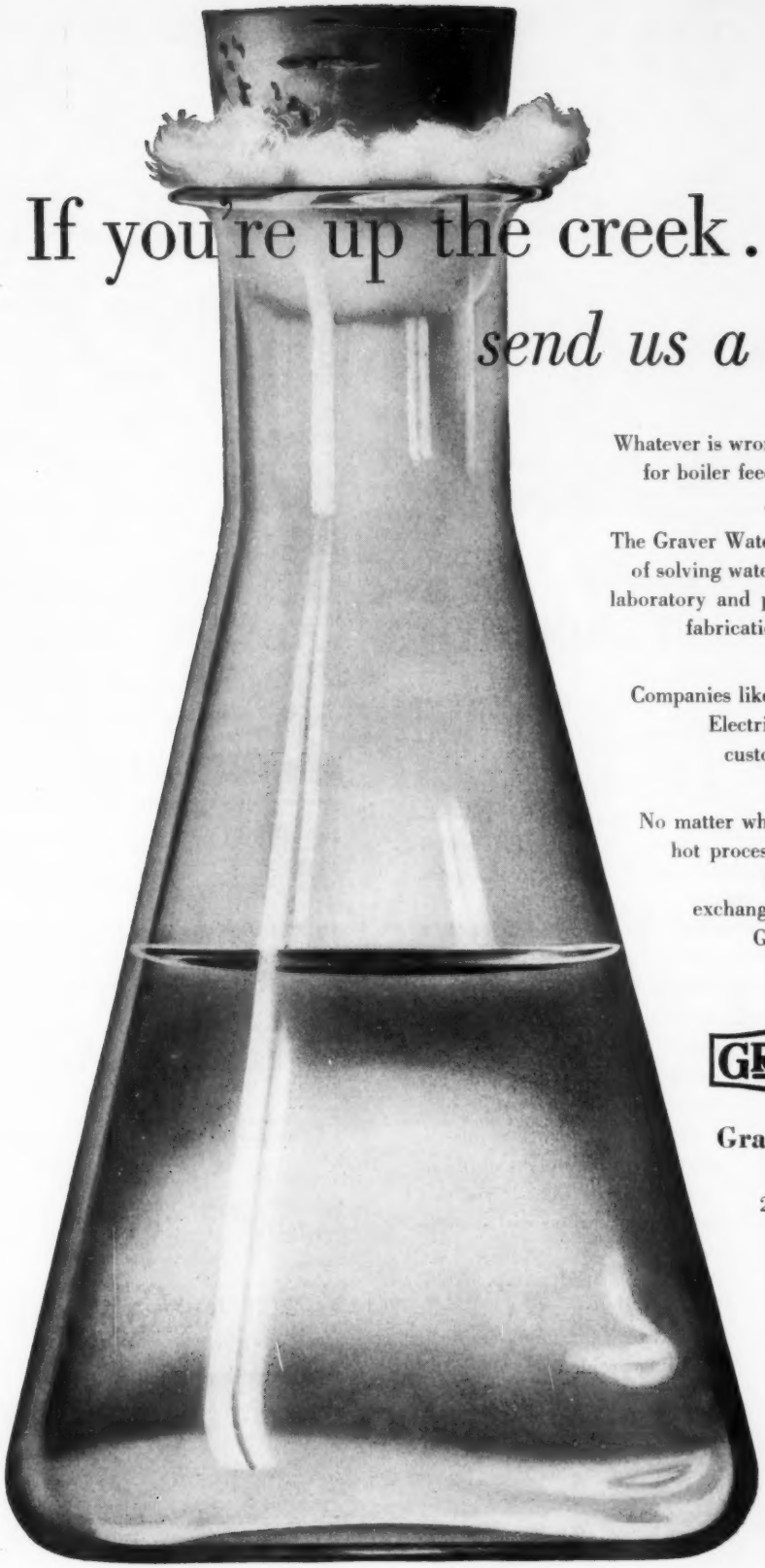

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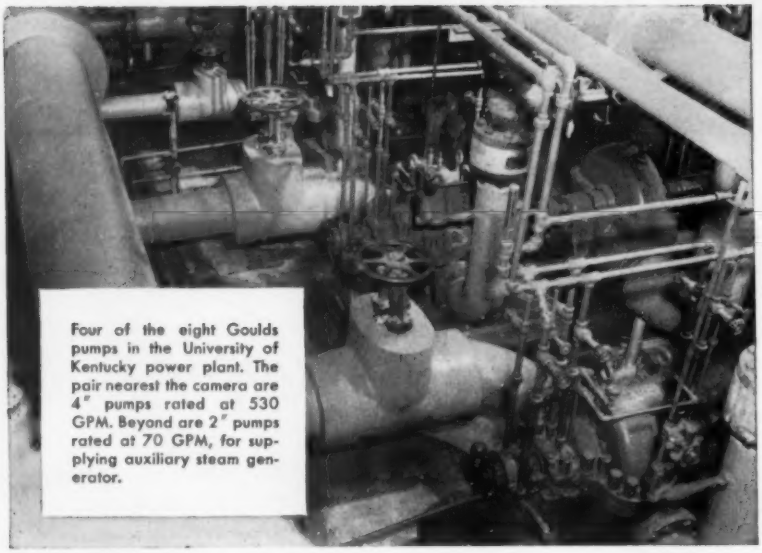

Four of the eight Goulds pumps in the University of Kentucky power plant. The pair nearest the camera are 4″ pumps rated at 530 GPM. Beyond are 2″ pumps rated at 70 GPM, for supplying auxiliary steam generator.

Boiler feed pumps TEACH STEAM PLANT ECONOMY

Doubling enrollment at the University of Kentucky meant increasing the load on the University's steam plant by 120,000 lbs. of steam per hour.

Failure of the steam plant would leave some 8,000 students and faculty without heat—and seriously cripple crucial scientific investigations. Obviously, reliability of equipment is essential. Flexibility, too—for economical operation during off-peak seasons. And, as space was limited, compactness was important.

Eight Goulds pumps for the new steam plant extension helped the University solve those problems. Four are 2-stage Fig. 3390 boiler feed pumps, supplying water to the steam generators at a head of 550 ft. The other four are condensate return and circulating pumps. All are compactly designed for minimum space requirements, and are precision-built for trouble-free operation and long service life.

Cross-section of Goulds Fig. 3390 centrifugal pump, showing opposed impellers, water-cooled stuffing box, and other construction features which make it a thoroughly efficient pump. Available capacities up to 1000 GPM. Heads to 900 ft.

Goulds pumps are available for every power plant application. Bulletin 722.3 gives detailed information and specifications of the popular Fig. 3390 boiler feed pump. We'll be glad to send you a copy or consult with you on any liquid-handling problem.

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Seneca Falls
New York

ARGUMENTS

Continued from page 146

A difference of one Btu between H_1 and H_2 gives a velocity of 224 fps. Four Btu difference gives 448 fps.

Let's suppose that in Marmy's Loose Screw case (January POWER) the ship's turbine was running with a fixed number of nozzles open and out of governor control. Or that they were all open with the turbine delivering full power. An increase in backpressure would work back to the first pressure stage, decreases flow through the nozzles, back up pressure in steam chest and take less steam from the boilers.

If boiler pressure was up to standard or a little higher, a sudden decrease in steam flow would start the safeties popping. Had the turbine been under governor control with some valves closed, they would have opened up and steam pressure would have dropped, temporarily at least.

I once operated a turbine with nozzle valves so rigged they could be undogged and operated by hand, thus taking them out of governor control. Increasing backpressure caused decrease in steam flow and less generator output.

ALBERT MOULTON *Pittsfield, Mass.*

More FREE BULLETINS

Begins on page 173

16 **Heavy duty limit switch** with trigger type mechanism. Two-color, 4-page bulletin. Photos and specs. Bulletin LS54A, Dept L, R B Denison Mfg Co, 102 St Clair Ave, NW, Cleveland 13, Ohio.

17 **Circuit breakers** for protection under unusual temperature variations. Two-color, 8-page bulletin. Complete photos and diagrams. Federal Electric Products Co, 50 Paris St, Newark, N. J.

18 **Diaphragm motor operators,** spring and springless type. Eight-page folder with complete diagrams and specs. Bulletin 414-1, Minneapolis-Honeywell Regulator Co, Wayne & Windrim Aves, Philadelphia 44, Pa.

19 **Emergency closing device** for air magnetic circuit breakers. Two-color, 4-page bulletin. Photos and specs. Bulletin 71B8105, Allis-Chalmers Mfg Co, 952 S 70th St, Milwaukee, Wis.

20 **Flexible shafting** for remote control of valves. Three-color, 16-page booklet. Photos, design and full specs. Bulletin 528, Stow Mfg Co, 181 Shear St, Binghamton, N. Y.

21 **Automatic controls** for steam, water, air, oil, and gas. Two-color, 4-page folder. Photos and specs. Bulletin C-50, McAlear Mfg Co, 1901 South Western Ave, Chicago 8, Ill.

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(Continued on page 256)

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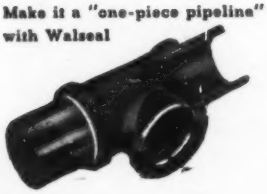

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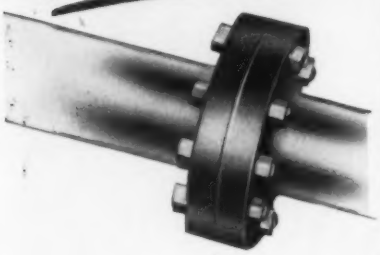

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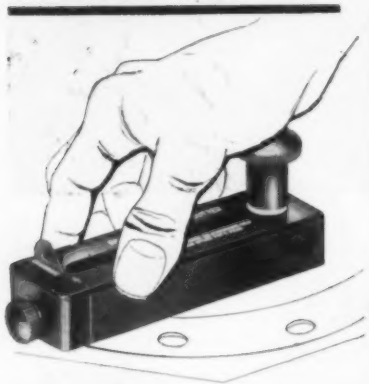

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(*Continued on page 258*)

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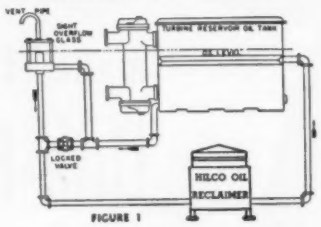

FIGURE 1

The HILCO system results in removing contamination as fast as it is formed, thus maintaining the oil in first class condition.

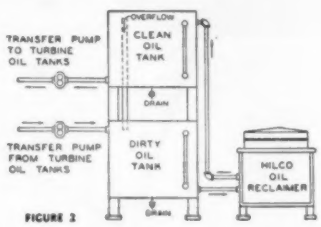

FIGURE 2

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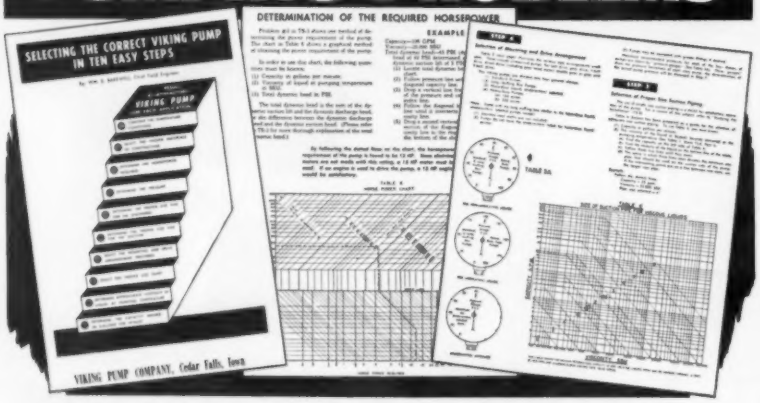
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Begins on page 173

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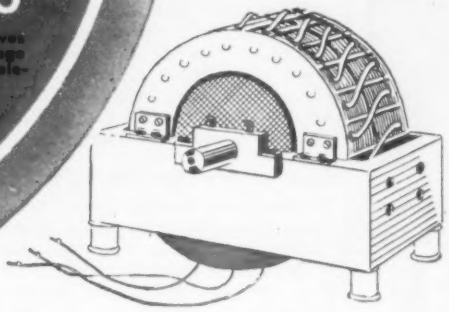

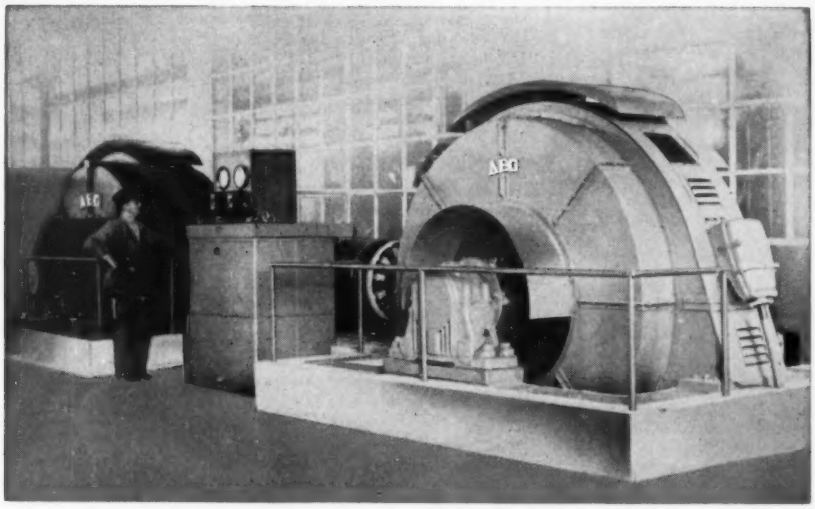

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APPOINTMENTS

Corporation Executive Changes

Stone & Webster Engrg Corp: Alfred L Hartridge and Stuart F Kosters, vice-presidents. **Carbide Power Co:** A L Foscue, president; John M Bandel, vice-president. **Public Service Electric & Gas Co:** Donald C Luce, president; Lyle McDonald, chairman of the board. **Johnston Pump Co:** Hugh Glen, president. **Quebec Power Co:** W F Mainguy, vice-president and a director.

Shawinigan Chemicals Ltd: Dr R Stephen Jane, executive vice-president succeeding H S Reid. **Downington Iron Works, Inc:** Herbert E ZBruder, president and treasurer succeeding Penrose M Davis. **Stephens-Adamson Mfg Co:** R W Brauer and D L Stephens, vice-presidents.

Operations Executive Changes

Westinghouse Electric Corp: William C Rowland, head of steam division; Chris H Bartlett, head of mfg and repair division succeeding Rowland. **Dravo Corp:** D R Berg, manager of piping dept; W L Davidson, manager of heating dept; E N Hower, asst manager of apparatus dept. **Vitro Corp of America:** G Russell Tatum, general manager of Vitro Laboratories; William B Hall, general manager of Vitro Uranium Co. **Laclede-Christy Co:** G A Fuchs, general superintendent of fire brick division.

New Sales Managers

Carver Pump Co: L C Lane, midwest regional operations. **Hammel-Dahl Co:** David Golner. **Standard Pressed Steel Co:** Francis J Kinsella, outside sales. **American Chain & Cable Co,** Wire Rope div: Nelson G Griffith, Atlanta district. **Fairbanks, Morse & Co:** Glenn A Parker, Kansas City branch. **Jay Mfg Co:** Howard E Butters, district manager of newly opened Cleveland office. **Orr & Sembower, Inc:** William B Firman, domestic sales.

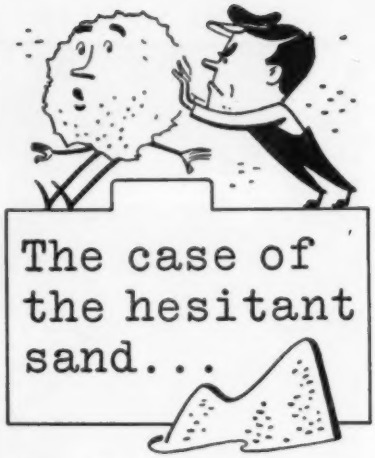
Link-Belt Co: Donald E Thal, central general manager, Pacific division; J Ross Arnold, Birmingham office. **Panellit, Inc:** Millard D Shriver, general sales manager. **Farr Co:** Harold M Robson, central division. **Graver Water Conditioning Co:** David M Spillane, Chicago district. **Anaconda Wire & Cable Co:** Jack Saunders, Florida sales.

Link-Belt Co: John D Riley, Cleveland office; Harry G Anderson, Newark office. **General Refractories Co:** Nelson W Bowman, Philadelphia office; Edward E Christopher, New York office; Thomas F Fallon, St Louis office. **Elliott Co:** G C Bayles, new sales office in New Orleans. **Wallace & Tiernan Inc:** Robert T Browning, vice-president in charge of sales; William A Hockett, director of sales, W&T division; Russell C Clement, field sales and service; Vincent Pisani, departmental sales.

New Sales Engineers

Flexible Steel Lacing Co: John Bakke, Mich., Ind. and western Ky. area. **Trane Co:** William M Baker, Canton, Ohio office;

(*Continued on page 262*)



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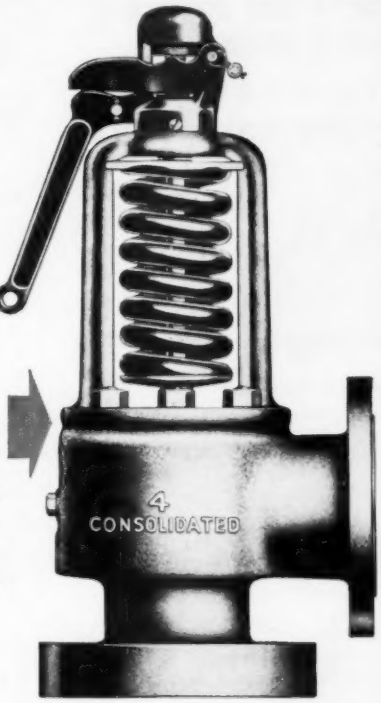


Dependable performance in hundreds of installations is the history of Consolidated Safety Valves Types 1411 and 1415. Time and time again, the high discharge capacity of these rugged valves has been thoroughly proved in the field. Positive, tight closing after operation is assured. Both types are simply constructed spring-loaded, wing-guided valves with few working parts. Adjustment is easy; maintenance economical.

Type 1411, with cast iron body, is excellent for installation on water tube boilers, mechanically-fired fire tube boilers, accumulators, unfired pressure vessels and pipe lines within its rated capacity. Types 1415, with cast steel body, is recommended for all applications beyond the scope of companion valve Type 1411.

Protect your personnel, facilities and production against the hazards of overpressures. Install precision-built Consolidated Safety Valves. Selection is easy. Write for Catalog 700.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

PPC

When You Buy

Pumps and Compressors

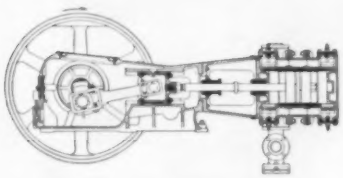
DO YOU WANT | LONG LIFE EASY MAINTENANCE RELIABILITY

These Are **BUILT-IN** *By* **PENNSYLVANIA**

AIRCHEK VALVE

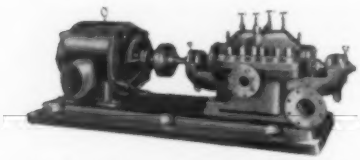
Automatically prevents reverse flow through Compressor and also dampens pipe line pulsations.

This Check Valve should be on EVERY Compressor. Bulletin 509 E



OILFREAIR & OILFREGAS Compressors Class ATL with steel-backed carbon cylinder-liners. Guaranteed to compress free of any trace of oil or oily vapors.

Bulletin 600 E



PENNSYLVANIA 4-Stage THRUSTFRE Centrifugal Pump for Boiler Feeding, General Power Plant and Industrial Use.

Bulletin 237 E

YOUR Copy of Catalog 546 briefly describes All PENNSYLVANIA Products. Write For It Today.

PENNSYLVANIA
Pump & Compressor Co.
EASTON, PA.

OILFREAIR® OILFREGAS®

THRUSTFRE® AIRCHEK®

James H Bennett, Greensboro, N. C. office; Henry N Casto, Clarksburg, W Va; Richard L Clements, Atlanta; Tyler G Hegenwald, New Orleans; William P Hutchins, Richmond; Donald Luallin, Seattle; Chester Milligan, Buffalo; William E Nero, Los Angeles; Amos L Roberts, Kansas City.

Potter & Brumfield: Robert Borland. **Graver Water Conditioning Co:** James J Hanratty, New York district; C W Miller, Iowa territory. **Delta Heating Corp:** E S Cushing, New England area. **General Electric Co,** Carboloy Dept: Robert Drake, Atlantic district.

New Distributors

Graybar Electric Co: new branches at 524 E St Louis St, Springfield, Mo. and at Sioux Falls, S. D. **Boston Woven Hose & Rubber Co:** new offices and warehouse facilities at 806 E 31st St, LaGrange Park, Ill; new warehouse at 2651 Gardner Rd, Broadview, Ill.

New Representatives

For **American Water Softener Co, Inc:** American Water Softener Sales Co, 75 West St, New York, N. Y. For **Poole Foundry & Machine Co:** Perry Engrg Co, 154 Nassau St, New York 38, N. Y. For **Hammel-Dahl Co:** James S Kone & Co, Amarillo, Texas. For **Hewson Co, Inc:** Riddle & Hubbell, 211 Midco Bldg, Tulsa 1, Okla.

Recent Moves

Multi-Amp Corp: entire facilities now at 10 Third St, Newark, N. J. **Dravo Corp:** Atlanta office now at Rm 361, 1401 Peachtree St NE, Atlanta, Ga. **Trane Co:** Canton sales office now at 2731 Cleveland Ave NW, Canton, Ohio. **Golden-Anderson Valve Specialty Co:** general offices now at 1232 Ridge Ave, Pittsburgh.

Obituaries

J Rexford Vernon, 58, vice-president and sales promotion manager of Johnson Service Co, February 17th.

E T Wilson Jr, 48, sales representative of Tubular Products division of Babcock & Wilcox Co, February 24th.

William H McGrath, 74, executive vice-president of Puget Sound Power & Light Co, March 1st.

More FREE BULLETINS

Continued from page 258

54 **Sodium zeolite water** softener designed for small and medium size industrial plants. Fully describes operation, design, capacities. Bulletin 4505-A, Cochrane Corp, Philadelphia 32, Pa.

PUMPS

55 **Diaphragm-type** controlled volume pumps. Two-color, 24-page booklet. Photos, diagrams, and specs. Bulletin 440, Lapp Insulator Co, Inc, Process Equipment Div, LeRoy, N. Y.

56 **High pressure** and capacity controlled volume pumps. Two-color, 2-page bulletin describes design and operation. Bulletin 1153-A, Milton Roy Co, Station L, 1300 E Mermaid Lane, Philadelphia 18, Pa.

57 **Diaphragm pumps.** Four-page bulletin illustrates new line. Features and specs. Rice Pump & Machine Co, Belgium, Wis.

This message from

Power

appeared recently in Business Week to remind management men throughout industry of the vast scope and key importance of power and of the men who direct the power services

Where does more muscle mean higher profits?

Some of your best friends in industry have discovered that the easiest, quickest way to increase profits today is plugging dollar leaks in power systems.

Why? Two of your heaviest costs, fuel and labor, have tripled in recent years. *And these two costs are among the most vulnerable to modern power equipment* . . . equipment that gets *more* power out of *cheaper* fuel, and gives labor more muscle for production.

POWER editors (talking to hundreds of power engineers in plants big and small) figure the *average* plant can cut its power price tag 25% through modernization. And this will often boost profits ten percent or even more.

The engineer in charge of your power services is probably a reader of POWER magazine, which is one reason he's well aware of what modernization can do. He would like to spend some time with you on this kind of arithmetic.

If you are working with outdated, cost-greedy power equipment, you're likely to find some wonderful answers. Better yet, you may also find a fast, smooth highway to bigger profits.

One of America's primary industrial media and a member of the Audit Bureau of Circulations

McGRAW-HILL . . . ABP

DARLING VALVES

INSIDE STORY...

on trouble-free valve performance

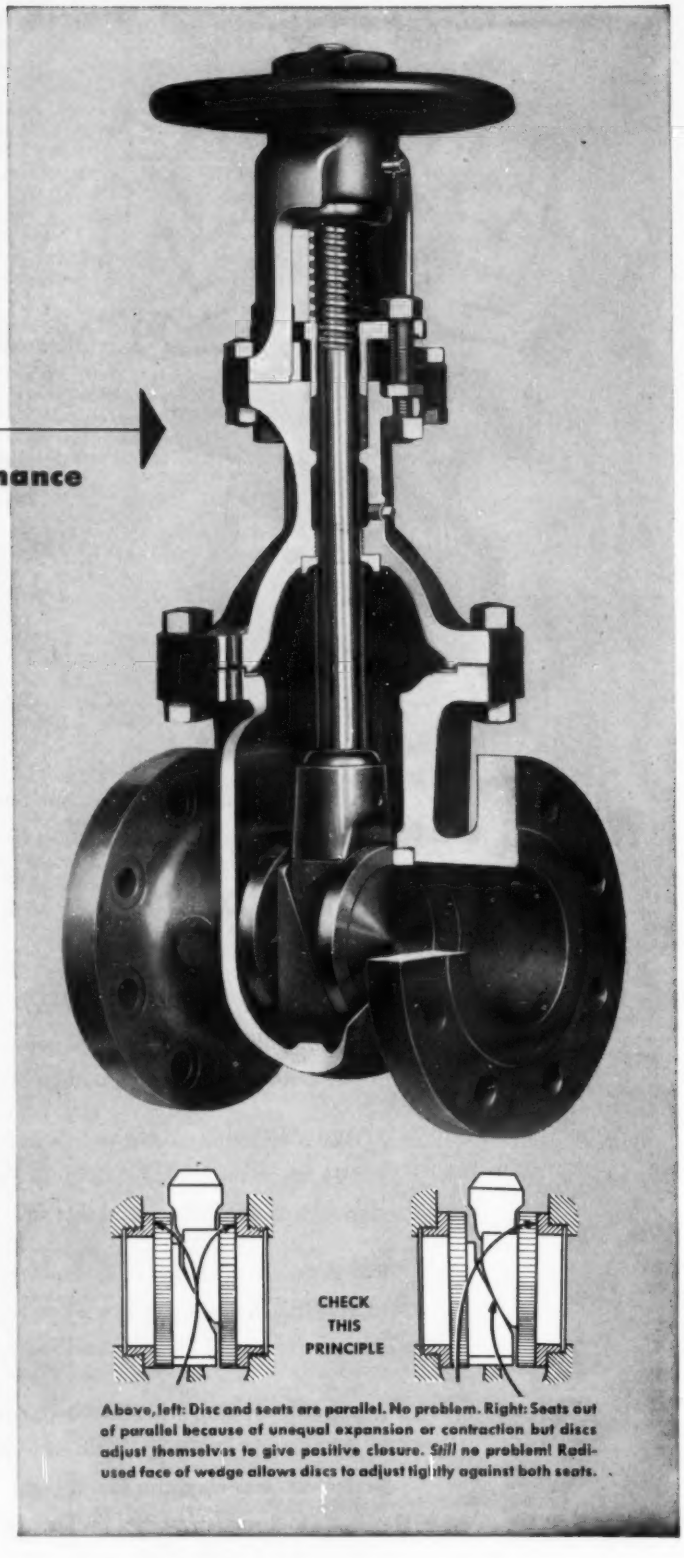
Install DARLING Revolving Disc GATE VALVES

Just what the doctor ordered . . . that's what users say about Darling fully revolving double disc, parallel seat gate valves. *Reason:* These unique valves adjust automatically to compensate for valve body distortion.

Moreover, Darling gate discs, independently hung from the upper wedge and free to revolve completely, change their seating position at each closing. This means uniform wear distribution. Valves work better and last longer, require less attention, less maintenance.

Wide Range Of Sizes And Types

If you're not already a Darling revolving disc gate valve user, let us prescribe the valve you need to cure *your* valve trouble. Darling gate valves come in a wide range of types and sizes . . . and for pressures up to 1500 pounds. Simply outline your particular service needs or ask for a complete descriptive bulletin.



Above, left: Disc and seats are parallel. No problem. Right: Seats out of parallel because of unequal expansion or contraction but discs adjust themselves to give positive closure. *Still* no problem! Radiused face of wedge allows discs to adjust tightly against both seats.

DARLING VALVE & MANUFACTURING CO.

Williamsport 8, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

RCA Industrial TV
Now Industry-Designed for Every **Heavy-Duty Job**

SMALL, RUGGED CAMERA—

only 10½" x 5" x 3½"—goes anywhere—sees with amazing definition—picks up fine meter readings—shows practically any operation or process in detail.

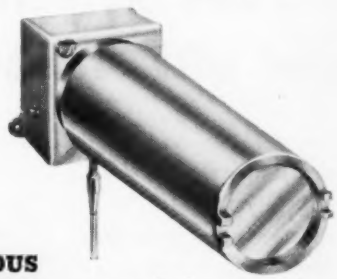
IMPORTANT:
New Low Prices Now in Effect!

PANEL-MOUNTING MONITOR—

fits your present control board—becomes an integral part of your instrumentation setup. All camera functions are controlled at monitor. Four-hundred-line resolution for high-definition image.

FOR OUTDOOR SUPERVISION—

new weatherproof housing protects camera from cold, heat, snow, and rain—makes RCA Industrial TV a true round-the-clock, round-the-calendar instrument.



FOR HAZARDOUS CONDITIONS—new explosion-proof housing lets you place your camera in any location too hazardous for your personnel.

FOR HIGH-TEMPERATURE OPERATIONS—

RCA's new water-cooled lens permits direct viewing of operations where temperatures run up to 2900°F.

FULL LINE OF ACCESSORY AND CONTROL EQUIPMENT DESCRIBED IN NEW, FREE BOOKLET

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In Canada: RCA VICTOR Company Limited, Montreal

Radio Corporation of America
Dept. E208, Building 15-1, Camden, New Jersey

Please send me the new booklet, *RCA Industrial TV.*

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Company_____

Address_____

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Two Terry Turbines equipped with "trouble eliminators"

Because these turbines have solid wheels, they can take a lot of abuse, without complaint. Here's why:

1. The wheel has no separate parts to become loose or work out. It is a single forging, in which a series of semi-circular buckets is milled.

2. Blade wear is of little consequence because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Wear does not materially affect horsepower or efficiency.

3. The blades cannot foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets in a direction at right angles to the shaft.

For complete details of these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TERRY

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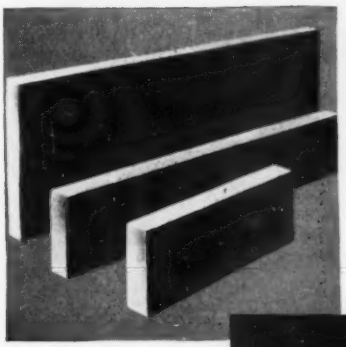
EAGLE-PICHER

Supertemp P-V Blocks



New light weight! Supertemp P-V Blocks are easily handled without breaking.

NEW STRENGTH AND LIGHT WEIGHT

for temperatures from

100 F. to 1900 F.

New strength of Supertemp P-V Blocks comes from a completely new manufacturing process developed by Eagle-Picher's research and engineering departments.

New light weight of Supertemp P-V Blocks results from the millions of "dead" air cells in Eagle-Picher's High Temperature Mineral Wool.

New strength plus extremely high thermal efficiency! Supertemp P-V Blocks are designed for continuous temperatures up to 1900 F. They're chemically and physically stable, too . . . ideal for heavy-duty insulating service.

New light weight makes P-V Blocks easy to handle—easy to apply—easy to cut for perfect fit. No special tools required.

And, of course, like all other Eagle-Picher insulation, Supertemp P-V Blocks soon pay for themselves in fuel savings and improved temperature control.

EAGLE-PICHER INSULSEAL PROTECTS! *Any insulation worth applying is worth protecting—and Insulseal provides a coating for insulation that dries to a flexible, hard, durable surface.*

Since 1843

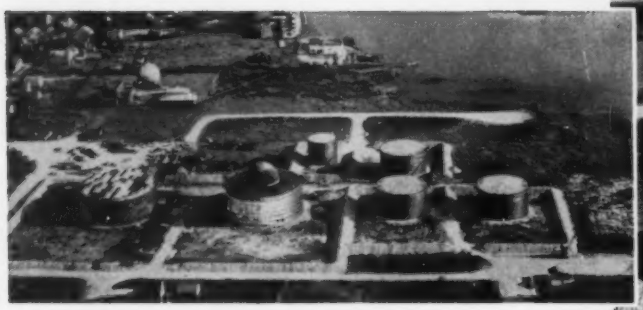
EAGLE EP PICHER

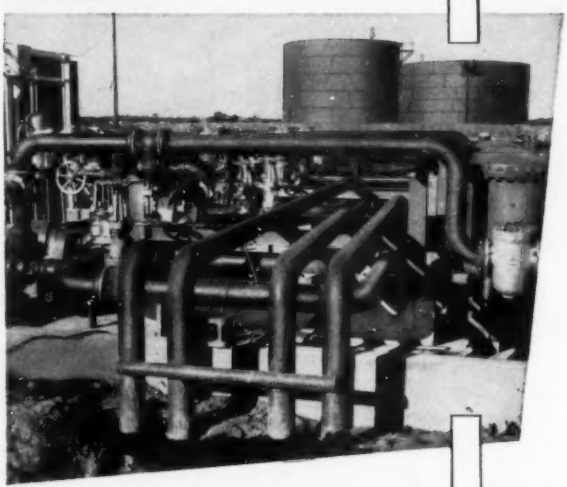
THE EAGLE-PICHER COMPANY

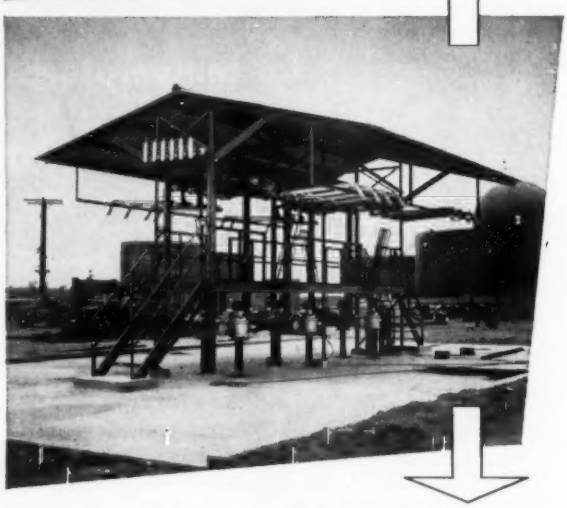
General Offices: Cincinnati (1), Ohio

Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

Member of Industrial Mineral Fiber Institute







A New Industry for Two Rivers...

The new marine oil terminal, owned by Two Rivers Terminal Corporation, Two Rivers, Wisconsin, demonstrates the variety of engineering-construction services in which Dravo Corporation's Machinery Division, Construction Department engages.

For this new port operation, Dravo fabricated and installed more than 16,000 ft of piping in the terminal area. Dravo's construction activities included the office building, pump house and loading platform; installation of the cast iron water service, vitrified clay pipe sewers, concrete foundations for the loading pumps and a modern foam-generating fire-fighting system. Dravo began work on July 27, 1953. The terminal was ready to receive oil on September 15, 1953.

Dravo's Construction Department is equipped with trained personnel—backed by more than 60 years of engineering experience—and capable of performing a wide range of construction assignments. Construction service includes all types of work from the installation of a pump to the construction of an entire plant on a "turn-key" basis.

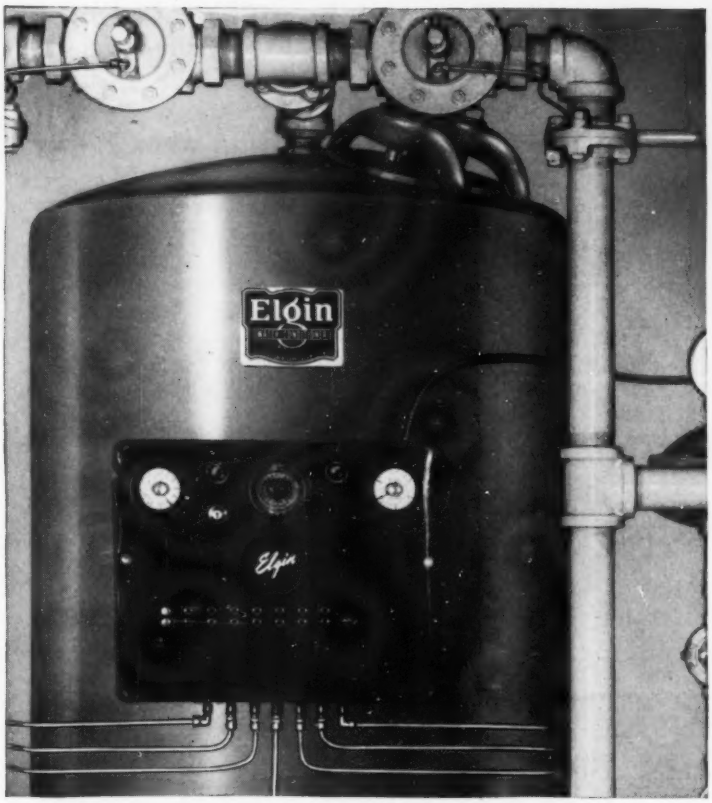
Let Dravo be your "Construction Department." Find out how you can profit through Dravo's single-contract service. Write for complete information and ask for Bulletin No. 1200. Dravo Corporation, Machinery Division, Fifth and Liberty Avenues, Pittsburgh 22, Penna.

Gasoline and fuel oil arriving at the terminal by barge and tanker are piped to six storage tanks with a total capacity of over nine million gallons. Then loading pumps deliver fuel to trucks at 650 gallons per minute.

DRAVO
CORPORATION
PITTSBURGH, PENNA.

Sales Representatives in Principal Cities

ELGIN ULTRAMATIC



America's Finest AUTOMATIC WATER SOFTENER

It's Hydraulically Operated by Magic Pilot

Costly Loss of Zeolite Prevented

The zeolite ion exchange material in this water softener is *"locked in"* by an ingenious "Double Check" manifold system to prevent costly loss, and to give more efficient regeneration. This manifold also permits far more exchange material to be placed in the softener to give up to 44% greater capacity so that a smaller unit will meet the need.

Your Softener Easily Converted to Automatic Operation

Save valuable manhours, eliminate human error, and increase the efficiency of your present water softener by converting to automatic operation. Write for details.

Here is today's most dependable automatic water softener—a product that sums up the best of all we have learned in nearly a half century of experience. It operates on the time proved hydraulic valve principle and is controlled by a new and unique automatic pilot to deliver a constant supply of zero soft water without attention.

The time interval and flow rate of each regenerating step of the Ultramatic is individually adjustable for maximum efficiency under any operating requirement or water characteristic. The reasons why this flexibility is highly essential to satisfactory performance, together with complete information about this water softener, are given in Bulletin 612. Write for your copy.

Elgin REFINITE SINCE 1908

ELGIN-REFINITE

DIVISION OF ELGIN SOFTENER CORPORATION

130 NORTH GROVE AVENUE, ELGIN, ILLINOIS

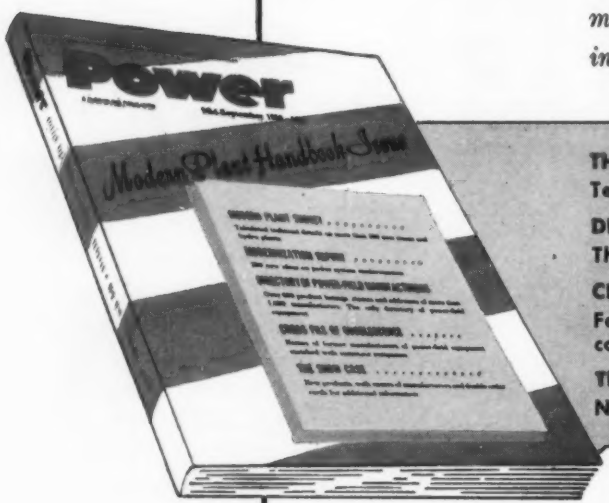
In Canada: G. F. Sterne & Sons, Brantford

OTHER PRODUCTS WRITE FOR BULLETINS } DeIonizers • Dealkalizers • Lime Soda Softeners • Deaerating Heaters • Filters • Treatment

THIS YEAR

POWER's Modern Plant Handbook (coming September 15) **will be bigger, more useful, closer than ever to the problems and progress of the power field.**

—for POWER readers *are taking an active part in writing the 1954 edition. "The Power Awards for Modernization" will present actual case histories of modernization programs, supplied by readers of POWER, showing problems, costs and results.—plus the other great features that make The Modern Plant Handbook an outstandingly useful issue:*



THE MODERN PLANT SURVEY
Technical details on over 500 new plants

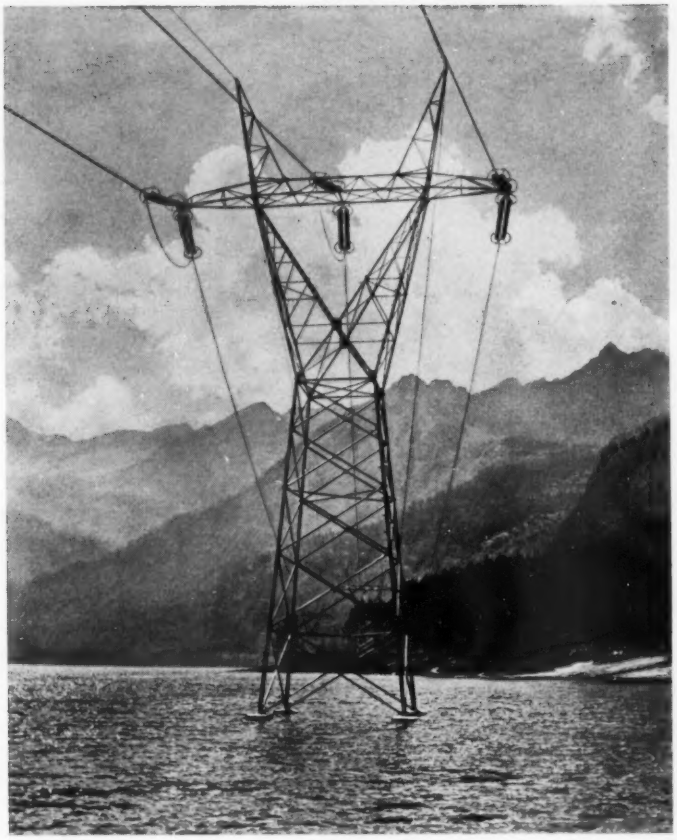
DIRECTORY FOR MODERNIZATION
The only directory of power-field equipment

CROSS FILE OF OBSOLESCENCE
Former manufacturers matched with successor companies

THE SHOW CASE
New products and their manufacturers

WATCH FOR THE HANDBOOK

You'll want to use it throughout the year



Lake Ceresole in the Piedmont Alps, Italy

DALMINE TUBING TOWERS Carry High Tension Lines Through The Alps ...*

DALMINE, S. P. A.
MILANO, ITALY
SEAMLESS PRODUCTS
CARBON AND ALLOY

CARBON—CHROME MOLYBDENUM—STAINLESS AND OTHER ALLOY PIPING FOR ALL POWER AND TRANSMISSION PURPOSES

Heater tubes, condenser tubes, and all other piping up to 32½ inches O. D., made in accordance with A.S.T.M. specifications.

With its modern seamless mill and precision controls, Dalmine offers the use of its vast experience in meeting the most exacting requirements for all Power needs.

**An example of Dalmine high-tension transmission towers. We solicit your inquiries for tubular prefabricated transmission towers manufactured by Dalmine, S.p.A.*

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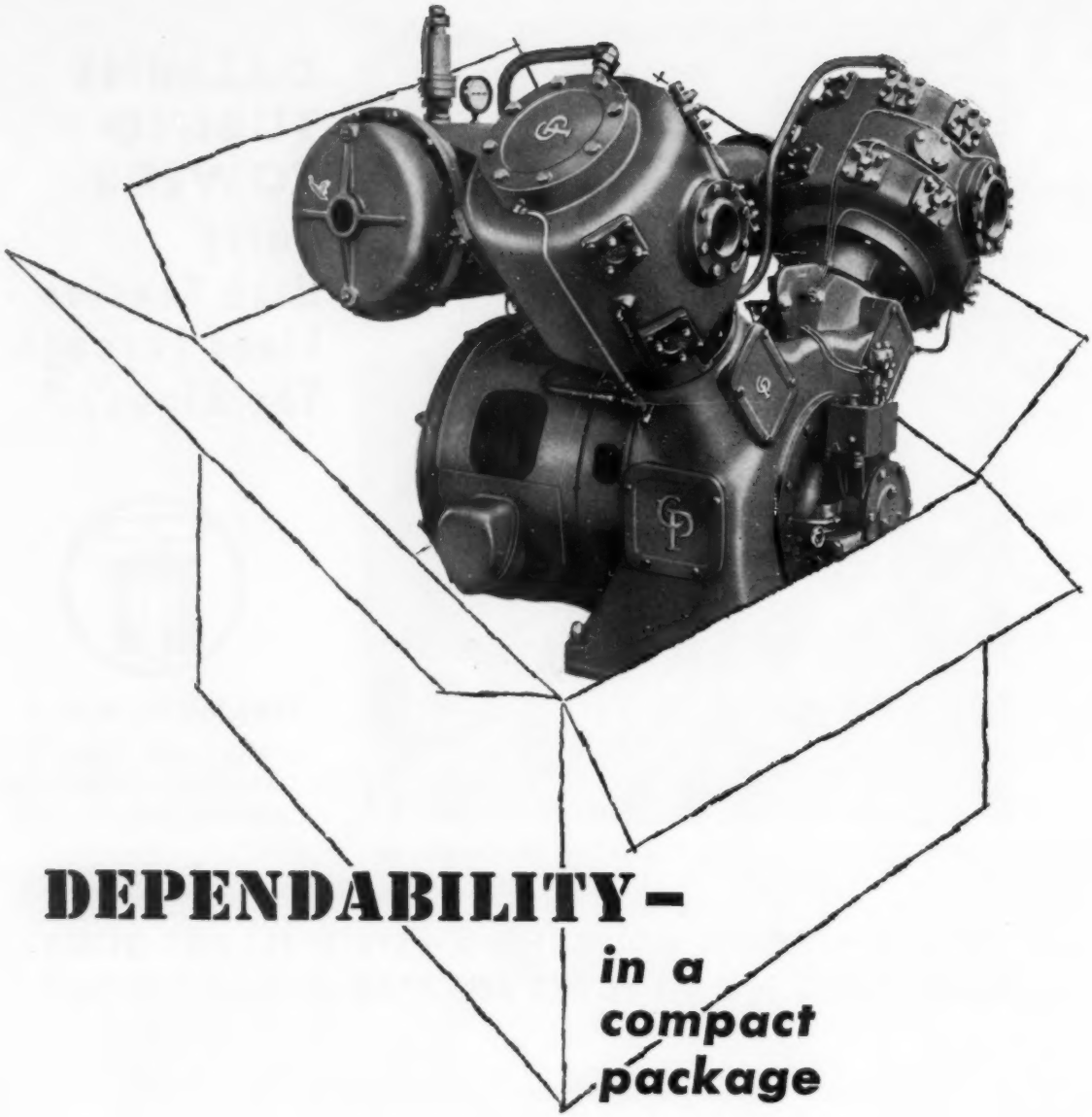


DEPENDABILITY—

in a compact package

With floor space at a premium, CP's space-saving Type Y Compressor is the answer! Shipped as a package ready for easy installation on a simple, inexpensive foundation, the dependable Type Y is designed for continuous operation and long life with high efficiency. Location of air inlet and discharge openings on cylinders permits the simplest and most compact piping arrangement. The "Y" arrangement also provides maximum accessibility to cylinders and to the easy-to-clean, easy-to-maintain shell-and-tube intercooler.

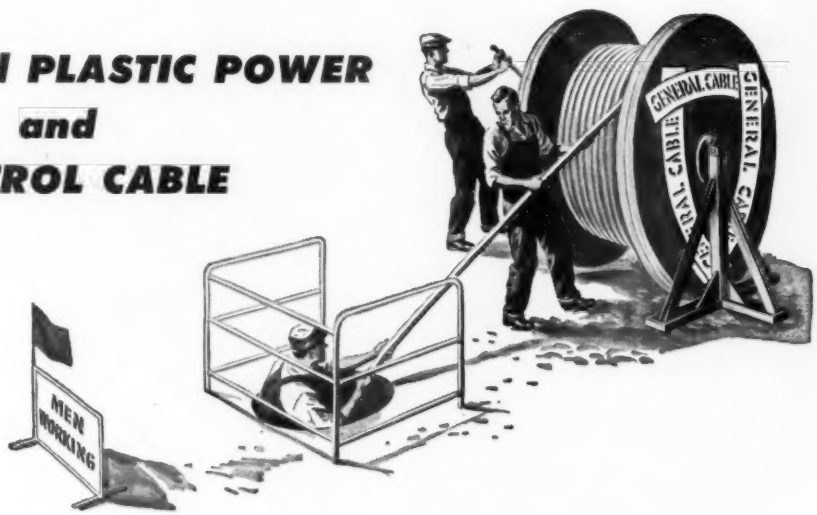
The Type Y has roller main bearings, precision connecting rod bearings, and multi-step capacity regulation. Available from 75 to 250 hp; 410 to 1663 c.f.m. capacity, and in single or multi-stage designs for a wide range of pressures. *Chicago Pneumatic Tool Co., 8 East 44th St., N. Y. 17, N. Y.*

Chicago Pneumatic

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE

RUBBER and PLASTIC POWER and CONTROL CABLE



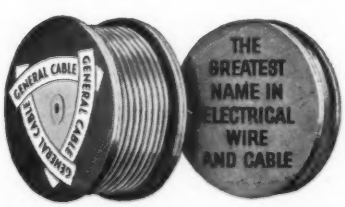
Besides offering the most complete line, General Cable makes top notch engineering service and useful product information easily available.

Rubber and Plastic Power and Control Cables are designed for power transmission, distribution and control...for duct and conduit installation...for direct earth burial...for submarine and aerial use (self supporting types are available).

Rubber or GENCORONE (corona resistant) oil base compound or plastic insulated...with braided, leaded, interlocked or submarine armored finish.

These popular and versatile lines of products are made to meet practically every operating condition. Get the full facts before you buy. Let our engineers help solve your wire and cable problems.

Every type for every use!



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IT TAKES *SMALL* PIPING, TOO

to produce BIG STEAM!

IT PAYS TO GIVE

Pittsburgh Piping

THE COMPLETE PIPING JOB

Piping for high-temperature, high-pressure stations is not all big, massive mains. Blowdown lines . . . even air lines carrying only about 100 psi are all parts of a chain—the links of which must be forged with equal skill.

Every engineer knows his biggest headaches are caused by "small" troubles. That's why, at P. P. & E., "little things" get great attention.

We test the molecular structure of weldments with the eagle eye of gamma rays . . . search for flaws with ultra-sonic sound . . . control annealing temperatures electronically—finally, install every part of a piping system, no matter how small, with the same degree of precision.

The end result is greater safety, higher efficiency, and longer service from a P. P. & E. installation.

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Houston.....Neils State Bank Bldg
New Orleans.....P. O. Box 74
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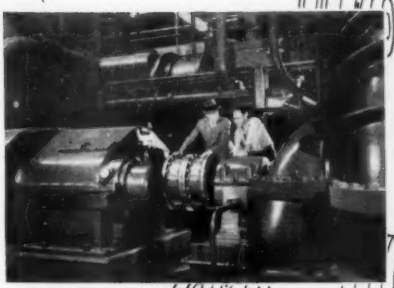
See why
FAST'S Couplings
are your wisest buy

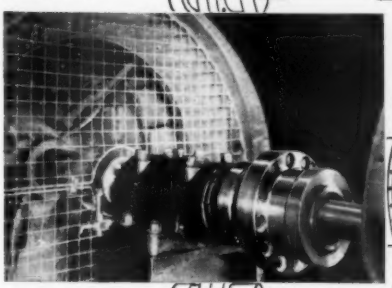
LESS DOWN-TIME. Industry finds that Fast's Couplings, the original gear type coupling, give trouble-free performance. They save on maintenance. Save money (often thousands of dollars in production losses) year in, year out, because there is no down-time due to breakage . . . no expense of replacing perishable parts.

LOWEST COST PER YEAR because Fast's Couplings usually outlast the equipment they connect. Many Fast's Couplings are still in use after 30 years. Why? Because they are ruggedly constructed of the sturdiest, most practical materials . . . all steel in construction, unique in design.

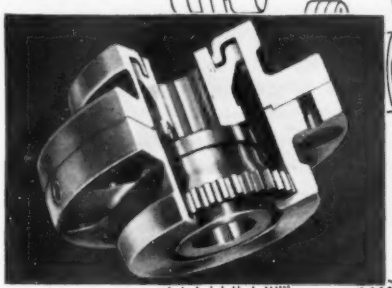
FREE ENGINEERING SERVICE. The same "Know-how" that goes into the manufacture of famous Fast's Couplings . . . that has resulted in over three-fourths of a million successful installations . . . applies to its extensive engineering service. 35 years of experience in developing the most satisfactory materials and designs, means our staff is well prepared to give you the most effective and cost-saving solutions to your coupling problems. Just outline and send them to Koppers for assistance. And send for free catalog. Just mail the coupon below.



Fast's Coupling installation in a modern power plant.



Close-up of Fast's Coupling, linking power to industrial fan.



Cutaway view of typical Fast's Coupling. Note unique design.

THE ORIGINAL

FAST'S Couplings

KOPPERS

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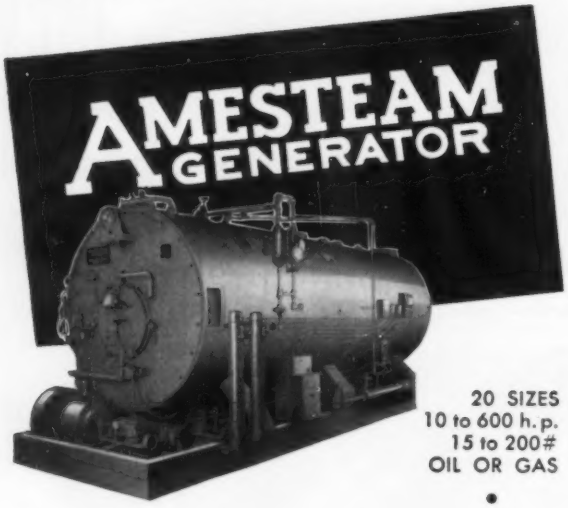

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10 to 600 h. p.
15 to 200#
OIL OR GAS

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JUST SET IT ON YOUR CONCRETE FLOOR — no special foundation or heavy stack are needed. You make BIG savings on installation of AMESTEAM GENERATOR because it's a complete, self-contained unit, ready to start generating steam!

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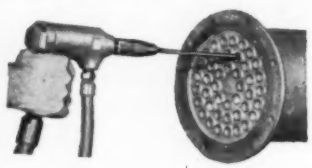
It's a cinch to clean any size heat exchanger tube the Wilson way!

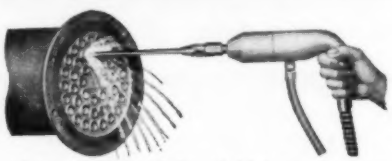
Why put up with the delays and the high costs of makeshift tube cleaning methods? Wilson has exactly the tube cleaner you need to do the job quickly, thoroughly, economically. Wilson's complete line of fast-acting tube cleaners includes the popular PG for ⅜" to 1", the PGX for intermediate sizes ½" to 1½", and the TP-301 for up to 2⅞" ID.

For Small Sizes
MODEL PG
PISTOL GRIP
TUBE CLEANER



The fast, efficient Pistol Grip Tube Cleaner provides the operator with one-hand control for cleaning small, straight tubes. Weighs only 3 lbs—no more than a 12" Stillson wrench.

For Intermediate Sizes
MODEL PGX TUBE CLEANER



Positive drive (not geared down) high speed, rotary shaft, air-driven scavenger type cleaner. Washes out tube and debris as it cleans, keeping drill bit cool at the same time. For either vertical or horizontal applications, straight or curved tubes.

For Heavy-Duty Service
MODEL TP-301
TUBE CLEANER

Suitable for vertical or horizontal use in straight or curved tubes ⅜" ID to 2⅞" ID and up to 40' long. Cleans rapidly, thoroughly, operating at high speed at 90 psi. Can run on pressure as low as 50 psi.

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TUBE CLEANERS • TUBE EXPANDERS

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The New FLEXON Expansion Joint Design Guide

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Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

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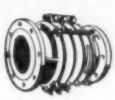
Expansion joints

Aircraft components

Metallic bellows

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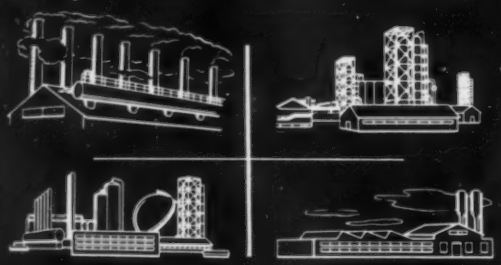
the Universal Sheet Packing for General Industry



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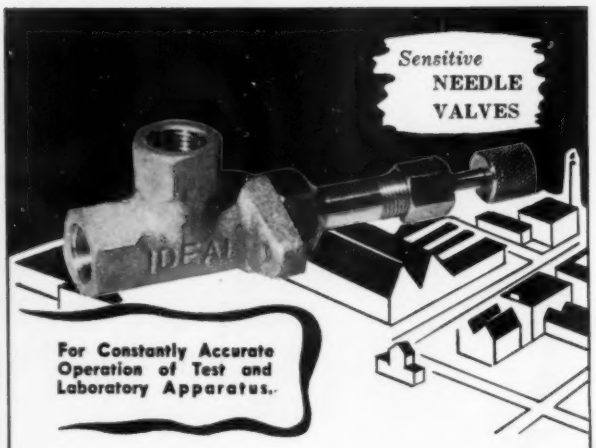
packing more performance into every application

GREENE, TWEED & CO. North Wales, Pa.



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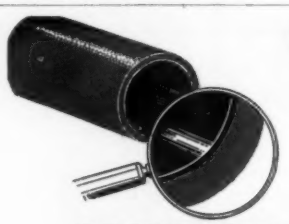

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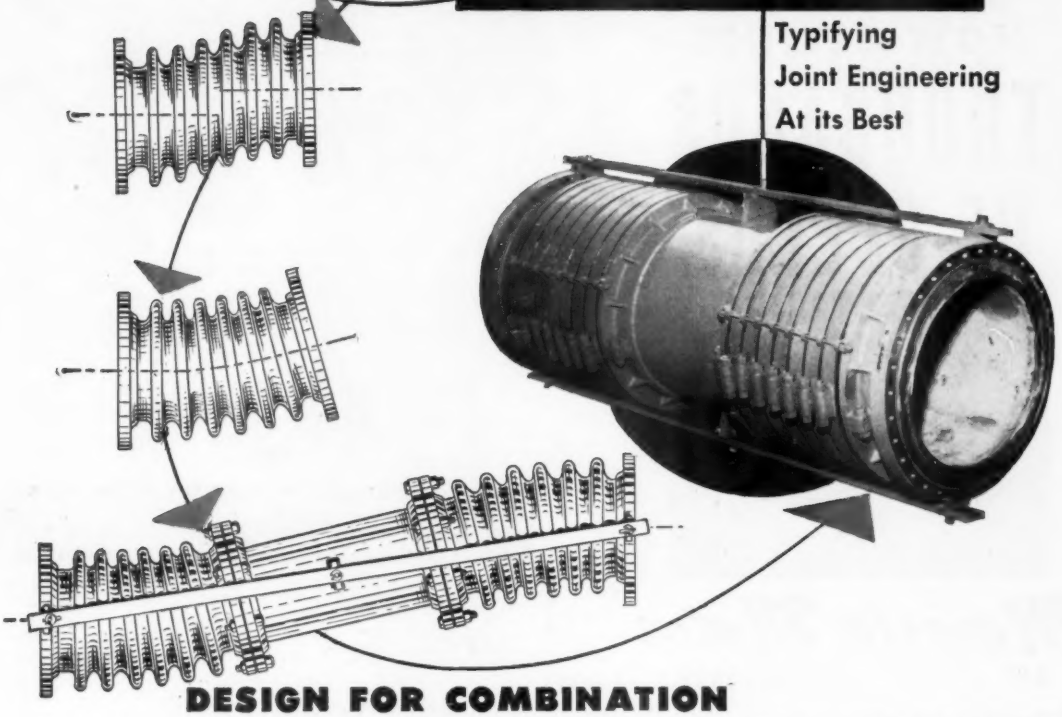

DESIGN FOR COMBINATION
LINEAR-SHEAR-LATERAL MOVEMENTS

Study these sketches showing (somewhat exaggerated, of course) several of the more complex movements to which expansion joints are often subjected. Do you have such pipe line conditions? Do you have any installation coming up that might involve such movements?

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Special Vibration Control Joints; Flexible Pipe Line Seals for watertight connection between pipe and flood walls.

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Original and Sole Manufacturer of Badger Expansion Joints

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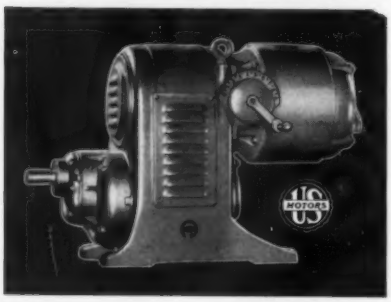

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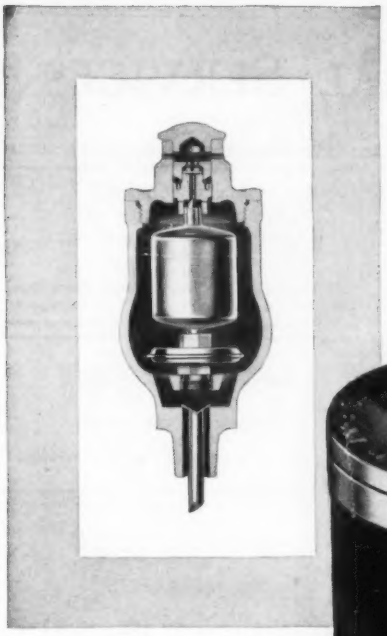

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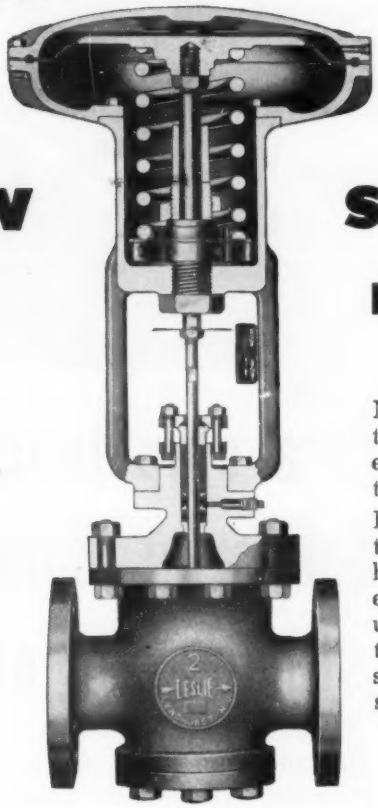

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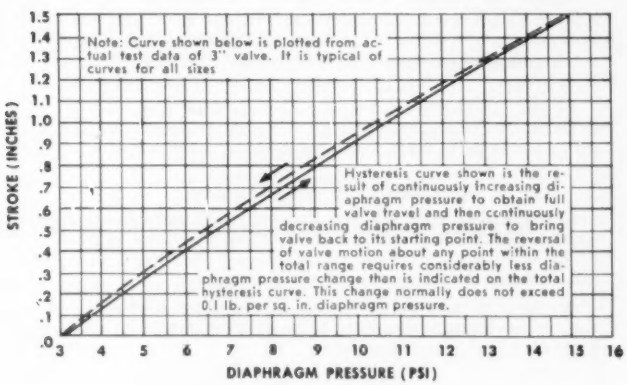
For instance, linearity (the straight line relationship between diaphragm pressure and inner valve movement) is held to plus or minus 2% for valve strokes up to 1½"—equivalent to .020" for valves with 1" stroke without using valve positioner. Hysteresis, the difference in position of the inner valve on the up and down strokes for the same diaphragm pressure, is held to 2% of full valve stroke for travel up to 1½". Here is the curve.


Note: Curve shown below is plotted from actual test data of 3" valve. It is typical of curves for all sizes
Hysteresis curve shown is the result of continuously increasing diaphragm pressure to obtain full valve travel and then continuously decreasing diaphragm pressure to bring valve back to its starting point. The reversal of valve motion about any point within the total range requires considerably less diaphragm pressure change than is indicated on the total hysteresis curve. This change normally does not exceed 0.1 lb. per sq. in. diaphragm pressure.
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1.4
1.3
1.2
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.9
.8
.7
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.3
.2
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SALES ENGINEER

Position as Sales Engineer for large valve and pipe fitting manufacturer, age 23-24. B. S. Degree in Engineering or equivalent essential.

Must be free to travel and to relocate following a reasonable period of factory training.

P-2413, POWER
520 N. Michigan Ave., Chicago 11, Ill.

HELP WANTED

Superintendent, Municipal Power Plant. Electrical or Mechanical Engineer with administrative experience preferred. Total plant installed capacity 21,000 KW. Near Chicago area. Hard Work with problems but good opportunity for right man.

Send full particulars of education, experience and salary with first application.

P-2464, POWER
520 N. Michigan Ave., Chicago 11, Ill.

REPLIES (Box No.):
Address to office nearest you
NEW YORK: 330 W. 42 St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

(Additional Position Vacant advertisement on the following page)

CONTROL ENGINEERS—Mechanical graduate familiar with design, application, selling, operation or servicing air or electric control systems. Eastern headquarters. Outline experience, etc. Address P-2268, Power.

SELLING OPPORTUNITY OFFERED

MANUFACTURERS AGENTS Wanted. Automatic Control Valve Manufacturer, Pressure Reducing, Temperature Regulating, Diaphragm Control Valves, desires exclusive sales representatives in open territories. Want agents that call on industrials, institutions, mechanical contractors, wholesalers and consulting engineers. RW-2372, Power.

EMPLOYMENT SERVICE

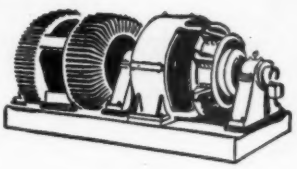
SALARIED PERSONNEL, $3,000-$25,000. This confidential service established 1927 is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. G, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

MAN WELL informed of Manufacturing, Technical and Personnel problems, seeks position as Functional Propitiator. P.O. Box #944, Warren, Ohio.

(Continued on the following page)

SEARCHLIGHT EQUIPMENT SPOTTING SERVICE



This service is aimed at helping you, the reader of POWER, locate used and surplus new power equipment not currently advertised (this service is for user-buyers only).

First, read the dealer ads on the following pages. A 5-minute study may locate the equipment *now*.

Second, send in the specifications of the equipment wanted on the coupon below, or on your own company letterhead, to

Searchlight Equipment Spotting Service
c/o POWER
330 W. 42nd St., N.Y. 36, N.Y.

Your requirements will be brought promptly to the attention of the used equipment dealers advertising in this issue. You will receive replies directly from them.

NO CHARGE • NO OBLIGATION

Searchlight Equipment Spotting Service
c/o POWER
330 W. 42nd St., New York 36, N. Y.

Please help us locate the following used equipment:

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.....

.....

.....

NAME ..... TITLE .....

COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

5/54

RE-NU-BILT
GUARANTEED

ELECTRIC POWER EQUIPMENT

D. C. MOTORS

Qu.	H.P.	Make	Type	Volts	RPM
1	2200	G. E.	MCF	600	400/500
1	2000	Whse.	Mill	600	230/460
1	1200	G. E.	MCF	600	750/950
1	940	Whse.	QM	250	140/170
1	900	Whse.		250	450/550
1	825	Whse.		250	95/190
1	600	Al. Ch.		250	400/800
1	500	Whse.	CC-216	600	300/900
1	500	G. E.	MCF	600	300/900
2	450	Whse.		550	415
1	400	G. E.	MCF	550	300/1050
1	300	Whse	CB-5094	250	575/1150

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G. E.	MT-498	2300	360
1	1500	ABB		2300	720
1	1200	G. E.	MT	2300	275
2	1000	A. C.	Mill	2300	240
1	1000	G. E.	MT-452	2200	321
1	500	G. E.	M-574Y	6900	900
1	500	Whse.	CW	550	350
1	450	G. E.	1M	440	720
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	350	G. E.	MT-442 Y	2200/4000	253
1	350	G. E.	IM-17A	440/2200	720
1	250	G. E.	MT-424-Y	4000	257
1	250	G. E.	MT-5598	2200	1800
1	250	Al. Ch.		550	600

SQUIRREL CAGE

2	650	G. E.	FT-550BY	440	3570
2	450	Whse.	CS-1420	2300/4150	354
1	300	Whse.	CS	440	1170
1	200	G. E.	IK-17	440	580
3	200	G. E.	KT-557	440	1800
1	150	Whse.	CS-8568	440	880
1	150	Whse.	CS	440	580
1	150/75	G. E.	IK	440	900/450
2	125	Al. Ch.	ARW	2200	1750

SYNCHRONOUS

1	4350	C. W.	3501-SL	13800/6900	514
2	3500	G. E.	TS	2300	257
2	2100	G. E.	ATI	2300	360
2	1750	G. E.	ATI	2300	3600
2	2000	Whse.		2300	120
3	735	G. E.	ATI	2200/12000	600
1	720	G. E.	TS	2300/4600	720
1	500	Ideal	SM	2300/4160	1800
1	500	Whse.		440	900
1	450	Whse.		2200	128.5
1	450	Whse.		2200	450
1	400	G. E.	TS	2200	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	D.C. Volts	A.C. Volts
2	2000/2400	G. E.	450	250/300	2300/4600
2	2000	G. E.	450	600	2300/4600
1	2000	G. E.	500 25cg	660	11000
2	2000	G. E.	514	600	6600/13200
1	1500	G. E.	720	600	6600/13200
1	1500	C. W.	514	30/115	4000/13000
2	1000	Whse.	900	600	4160
3	1000	G. E.	720	600	2300/4600
1	1000	G. E.	900	260	6600
1	1000 (3U)	G. E.	900	250	2200
1	750	Whse.	900	275	4160
1	750	C. W.	514	30/115	2300
1	600	G. E.	720	250	440/2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	5000	Whse.	OISC	3	3300x26400
1	2500	Whse.	OISC	3	26400/13200x460
3	2000	G. E.	HVDDJ	1	66000/138000
1	1500	G. E.	HT	3	13200x2300
3	1000	G. E.	HVDDJ	1	2400x480
6	1000	Wagner	OISC	1	11200x460

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	3000	G. E.	60/25	2300/2300/4000
2	2500	G. E.	25/62.5	2300/2300
1	1000	G. E.	25/58.3	4400/2300
1	500	Al. Ch.	2560	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G. E.	Condensing 425—750 F. T. T. Surface Condenser 3/60/2300/4000 V Direct conn exciter.
1	1500	Whse.	Auto-extraction 190 lbs.—600° F.T.T. 60 lb. extraction 3/60/240 V. Div. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
1	1000	G. E.	Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.B.P, 480/3/60.
1	750	G. E.	Condensing 265 # I.S.P. 440V. 3 ph. 60 cy.—New—1944.
1	750	Whse.	—Non-condensing 135# I.S.P. 40# B.P. 750 Kw. 280 V. D.C.

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.

PROJECT ENGINEER

Established Engineering and Construction Company offers staff position to qualified mechanical engineer. The work involves steam power plants and requires a Project Engineer capable of supervising plant layouts and design, selecting equipment and auxiliaries. Midwestern location, liberal employee benefits, and insurance program. Furnish detailed resume of experience, references, recent snapshot, if available, and salary requirements.

P-2463, POWER

520 N. Michigan Ave., Chicago 11, Ill.

POSITIONS WANTED
(Continued from preceding page)

POWER ENGINEER: M.S.M.E., 4 years experience, operation and test of steam power equipment. Desires responsible position including technical operation, plant betterment or development work. PW-2491, Power.

SALES MANAGER or General Manager—Successful record marketing mechanical, industrial and hydraulic equipment to industry thru direct sales, OEM, or dealer organization. Graduate engineer, age 42. Position offered must require high level and policy responsibility. PW-2408, Power.

STEAM POWER PLANT Superintendent with nine years experience operating oil and coal fired boilers and generating equipment. Technical education. Age 33. PW-2350, Power.

YOUNG ENGINEER—13 years experience installing—testing and operating turbines and stokers—fans—pumps for one of largest manufacturers—is tired of traveling and would like to get job as assistant to Plant Engineer in medium-size plant in South or Southwest. Married—sober and dependable. Can furnish A-1 references. PW-2166, Power.

EXPERIENCED SWITCHBOARD Operator would like operating job in central or substation. PW-9867, Power.

SELLING OPPORTUNITY WANTED

DEAERATOR WANTED Conditioning equipment account. 13 years experience in field. Howard Egginson, 225 West 34th St., New York 1, N. Y.

WANTED

ANYTHING within reason that is wanted in the field of Power can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

GET 2nd ENGINEER PAPERS IN 1 YEAR

(Yes, get better stationary engineers License!)

No correspondence school bother. Nationally-known Chief Stationary Engineer Frederick C. Walker's 100-Question, 100-Answer Bulletins give you the straight dope quick. Send $3 to Walker & Collins, 524 Ashland Ave., Buffalo 22, N. Y. for first set today. Keep working. Save year.

WANTED

WE BUY NEW & USED ELECTRICAL SURPLUS

Wire & Cable • Conduit Fittings
Wiring Devices • Switches
Electronic Components • Fuses
Motors • Transformers, Etc.

Phone—Rochester GLenwood 8840

DIAMOND ELECTRIC CO.
P. O. BOX 1632 • ROCHESTER 3, N. Y.

WANTED IN GOOD CONDITION

2—450 HP Fairbanks-Morse Diesel-Generator Sets, Model 32E14, 300 R.P.M., 6 cylinder, 2 cycle Direct connected to 375 KVA A.C. Generators 2400 volts 3 Phase, 60 Cycle with Exciters; with or without Switchboards.

1—250 KVA Generator, 2400 volt—3 Phase, 60 Cycle, 300 R.P.M.—for direct connect to Fairbanks-Morse Diesel Model 32E14, 300 HP.

1—150 KVA Generator, 2400 volt, 3 Phase, 60 Cycle, 327 R.P.M.—for direct connect to Worthington Diesel 180 HP.

Submit details, locations and prices in first letter.

W-2298, POWER
330 W. 42nd St., New York 36, N. Y.

$ CASH MONEY $

WE BUY ELECTRIC SUPPLIES • MOTORS • TRANSFORMERS • WIRE • CABLE
SEND LISTINGS
ALLIED ELECTRIC COMPANY
Box 1838—1122 Falls Bldg., Memphis, Tennessee

Somebody—Somewhere,

needs your idle equipment! Reach that buyer quickly and economically thru the

"SEARCHLIGHT SECTION"

The meeting place of Used Equipment Buyers and Sellers

REBUILT—GUARANTEED ELECTRICAL EQUIPMENT

DIRECT CURRENT MOTORS
230-V. D.C.

Qu.	HP	Make	Type	RPM
6*	3000	Whse.	Mill	600
14*	1500	Whse.	Mill	600
10*	800	Whse.	Mill	600
8	700	Whse.	Mill	285/700
1	350	G. E.	CD-169	1150
1	250	G. E.	MPC	325/975
1	200/250	G. E.	MPC	300/900
1	200/250	El. Dy.	Size 22	400/1200
1	200	Whse.	Mill	300/1200
1	180	G. E.	MPC	400
1	160/90	G. E.	MPC	625/1125
1*	125	Whse.	SK-190	600
2	125	Whse.	SK-184	575/850
6	100	El. Dy.	30-S	450/1100
6	75	C.W.	53 H	860
1	50	Whse.	SK	250/1000
1	40	Whse.	SK-140	500/1700
1	35	G. E.	QD-125	400/1200
1	35	G. E.	CD-147	300/1200

*—525 and 600 V. D.C.

MOTOR GENERATOR SETS

Qu.	KW	Make	RPM	Volts DC	Volts AC
1 (3U)	2400	Whse.	720	600	4800/2400
2	1750	G. E.	450	250	4600/2300
2	1200	Whse.	720	600	2300
2	1000	G. E.	900	600	13200/6600
1	500	C. W.	720	575	2300/440
1	400	C. W.	1200	125/250	2300/440
1	400	C. W.	720	250	2300/440
1	300	Whse.	900	250	2300
1	150	G. E.	720	250	2300/440
1	100	Ridgway	1200	275	4000/2300
1	100	C. W.	1200	125	440/220
1	100	Whse.	900	250	2300

SLIP RING MOTORS
Constant Duty 3 phase 60 cycle

Qu.	HP	Make	Type	Volts	RPM
1**	1800	G. E.	MT-498	2300	357
1**	1200	G. E.	MT-26	2200	277
1	700	G. E.	I-M	2300	400
1*	600	G. E.	MT-20	2300	360
1**	500	Al. Ch.	ANY	2200	514
2	500	G. E.	I-16-M	2300	450
2	400	G. E.	MT-412	2200	450
1	300	G. E.	I-M	2200	600
1	250	Whse.	CW-937	440	1200
1	250	G. E.	MT-414	2200	300
1	250	Al. Ch.	ARY	440	720
2	100	G. E.	I-15-M	2300	514

**Pedestal bearing design

SQUIRREL CAGE MOTORS
3 phase 60 cycle

Qu.	HP	Make	Type	Volts	RPM
1	400	G. E.	IK	2300	514
1	300	Whse.	CS 890	2300	1750
1	200	Al. Ch.	A.R.	440/220	580
1	200	Whse.	CS 873 C	2200	1160
2	125	Al. Ch.	A.R.	2300	1750
1	125	Al. Ch.	A.R.	2300	490
1	100	G. E.	KT 562	440/220	570
1	100	Whse.	CS 938	2200	495

SYNCHRONOUS MOTORS
3 phase 60 cycle

Qu.	HP	Make	PF	Volts	RPM
1	3000	Whse.	80	4800/2400	720
2	2100	G. E.	100	2300	360
2	2000	G. E.	80	2300	720
2	1750	G. E.	100	2200	3600
1	750	G. E.	80	2300	450
1	710	G. E.	80	2300/440	720
1	250	G. E.	100	2300	514
1	250	G. E.	80	2300	600
2	200	Whse.	80	440/220	1200
1	187	G. E.	80	440/220	720
1	150	G. E.	100	2200	900
1	150	G. E.	80	440/220	450
2	135	G. E.	80	4000/2200	1200
1	125	G. E.	80	2200	900
2	100	Whse.	80	440	1800
2	100	G. E.	80	440/220	600

TRANSFORMERS
60 Cycle

Qu.	KVA	Make	Phase	Voltage
3	750	Pitts.	1	23,000-2300
3	667	Wagner	1	22,000/11,000-2300/4000
3	500	G. E.	1	22,000/11,000-2300/4000
3	150	Al. Ch.	1	4160/7200-240/480
3	100	G. E.	1	33,000-2300
3	25	G. E.	1	2400-120/240
42	3	Al. Ch.	1	2400-120/240

PURC. AGENTS—PLT. SUPT.—PLT. ENGR.
"MAY WE SEND YOU OUR CATALOG 553?"

T. B. MAC CABE COMPANY

AIR COMPRESSORS—ELEC.

3040 CFM Sullivan WN4—2300 V.
3074 CFM Chgo. Pneu. OCE—2300 V.
2—2200 CFM Chgo. Pneu. OCE—440 & 2200 V.
2—1722 CFM Chgo. Pneu. OCE—440 & 2200 V.
1750 CFM Worthington—440 V.
3—1302 & 1090 CFM—Inger. Rand 2200 V.
STANHOPE, 60 E. 42nd St., N.Y. 17, N.Y.

NOW IS THE TIME TO BUY....

"Certified Rebuilt" Motors and Generators

HIGHEST QUALITY . . . REDUCED PRICES

Check with **WAGNER** *First*

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4060/2300	900
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
625	El. Machy.	Late	240/480	1200
485	Allis Ch.	1 brg.	480	400
350	El. Machy.	1 phase	480	1200
312	Gen. Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
225	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
150	Allis Ch.		240/480	1200
150	Gen. Elec.	ATB	2300	900
150	Whse.		2300/480	600
125	El. Machy.	Syn.	240/480	1800
125	Gen. Elec. (2)	ATB	240/480	900
112	Gen. Elec.	ATB	240/480	900
75	El. Machy.		2300	900
56	G. E.	ATB	240/480	1200
25	Whse. b.b.	1 phase	120/240	900

LOW VOLTAGE M-G SETS—2
Whse. 3636 amp. 20/55 V DC gen. w/synch. motor 220/440 V. 720 RPM and exciters.

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
250	Allis. Ch. b.b.	EW	350	1200
250	Gen. Elec.	MPC	250	600
200	Gen Elec.	RC	250	1150
150	Gen. Elec. b.b.	CDM	250	1500
105	Century b.b.	1500 amp.	70	1200
100	Allis Ch.	E	125	1200
100	Allis Ch. (2)	EI82	250	900
75	G. E. b.b. (2)	CDM135	125	750
75	Whse.	SK	250	900
75	Columbia b.b.		120/240	1450
60	Allis Ch.	E147	250	900
60	Whse. b.b. (2)	SK121	300	1200
50	Reliance	T	250	1150
50	Allis Ch.	EW	125/250	1200
40	Gen. Elec.	CD103	250	1500
40	F. Morse b.b.	DH	125	1800
40	Gen. Elec.	RC	600	1750
25	Whse.	SK93	125	1750
25	C. W. b.b. (2)	CCD	250	1200
20	Gen. Elec.	RC	125	1150

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
750	Whse.	Synch.	2200/4000	900
700	G. E.	Synch.	2200	514
600	E. M.	Synch.	480	1200
550	G. E.	Sq. Cage	2200	3600
500	G. E.	Slipring	2200/440	450
500	G. E.	Synch.	440	900
450	Allis Ch.	Synch.	480	400
400	Whse.	Sq. Cage	2200	514
400	G. E.	Synch.	440	450
400	Allis Ch.	Sq. Cage	2200/440	1200
350	Whse. (2)	Slipring	2300	450
300	El. Machy.	Synch.	220/440	360
300	Al. Ch.	Sq. Cage	2200/440	720
300	Whse.	Synch.	2200/440	600
300	Al. Ch.	Slipring	2300	514
300	G. E.	Slipring	440	360
250	G. E.	Synch.	220/440	720
250	Whse. (2)	Sq. Cage	2200/440	1200
250	L. A. (2)	Sq. Cage	2200	1800
225	G. E.	Synch.	220/440	900
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2200/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse	Sq. Cage	2200/440	900
200	G. E.	Slipring	220/440	600
200	E. M.	Synch.	220/440	1200
200	G. E.	Slipring	220/440	360
200	Whse.	Sq. Cage	220/440	1800
200	E. M.	Synch.	220/440	514
200	Wagner	TEFC	2200	1200
175	G. E. (2)	Synch.	220/440	720
175	Whse.	Synch.	220/440	360
150	Whse.	Sq. Cage	220/440	900
150	G. E. TEFC	Sq. Cage	2200	3600
150	Allis Ch.	Slipring	2200/440	720
150	G. E.	Synch.	220/440	450
150	Allis Ch.	Slipring	2200/440	720
150	G. E. (2)	Sq. Cage	2200/440	720
150	G. E.	Slipring	220/440	450
150	Allis Ch.	Sq. Cage	2200/440	1200
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G. E. (2)	Slipring	220/440	600
125	G. E.	Slipring	220/440	450
125	E. M. (2)	Synch.	220/440	1800
125	Allis Ch.	Slipring	220/440	900
100	G. E. TEFC	Sq. Cage	220/440	1200
100	G. E.	Slipring	220/440	900

48 Years of Service to American Industry

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	350	1000
250	Gen. Elec.	LDR	250	450/850
200	G. E. (2)	RC59	230	850
150	Whse.	SK-201	230	300/900
100	Allis Ch.	E182	230	600/1200
75	F. Morse b.b.	DH140	115	1600
75	Whse.	SK170	230	635
60/75	Gen. Elec.	C	230	500/1200
50	Reliance	310T	230	850
50	Reliance b.b.	651T	230	750
50	Gen. Elec.	CD123	230	550/1200
50	Cr. Wh. b.b.	FH	230	1750
50	Whse.	SK183	230	300/900
40	Whse.	SK143	230	600/1500
40	Reliance	651T	230	350/1000
40	Allis Ch.	E-121	230	1750
40	Gen. Elec. (2)	CD103	230	1150
40	Gen. Elec.	RC32	550	1200
40	F. Morse b.b.	DH 120	115	1750
30	Imperial b.b.	D69	230	400/1600
30	Star b.b. (3)	SB	230	1750
25	Whse.	SK150	230	300/1200
25	Gen. Elec.	CD105	230	575/1720
20	G. E. series	CO-1826	230	875

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
300	G. E.*	440 AC	250 DC
300	Allis Ch.	2200/440 AC	125/250 DC
300	Whse.*	2300 AC	600 DC
250	Allis Ch.	2200/440 AC	350 DC
200	Whse.* (2)	220/440 AC	55 DC
200	G. E.*	220/440 AC	250 DC
200	Gen. Elec*	220/440 AC	125 DC
105	Century b.b.	220/440 AC	70 DC
100	Al. Ch.	220/440 AC	125 DC
100	Delco b.b.	220/440 AC	125/250 DC
80	Star* b.b.	220/440 AC	240 DC
60	Gen. Elec.*	220/440 AC	60 DC
60	Whse. (2)	220/440 AC	300 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Allis Ch.	220/440 AC	125/250 DC
50	Cr. Wh. b.b. (2)	220/440 AC	240 DC
40	G. E. (2)	220/440 AC	250 DC
40	Gen. Elec.	220/440 AC	600 DC
25	Whse.	220/440 AC	125 DC
25	Gen. Elec.	220/440 AC	250 DC
20	Star b.b.	220/440 AC	120 DC
16	Gen. Elec.	220/440 AC	125 DC
15	El. Prod.	220/440 AC	40 DC

10,000 other items in Stock.
Send for our complete listings.

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There's more than 40% to 60% SAVINGS on

SCHOONMAKER DEPENDABLE DIESEL POWER

because:

Each Schoonmaker-sold Diesel Engine Unit is fully REMANUFACTURED in our plants by highly skilled, factory-trained Diesel engineers. Only genuine factory-made and approved parts are used and all REMANUFACTURING is in strict accordance with manufacturer's recommended procedures. Prior to shipment every engine is subjected to a FULL LOAD operating test in accordance with DEMA standards.

The Schoonmaker Plants and Warehouses located in Jersey City, N. J. and Sausalito (San Francisco), California give NATIONWIDE SERVICE from Coast to Coast with modern, efficient and reliable facilities.

Our reputation and many years of experience and SPECIALIZATION in Diesel power equipment gives you value that money cannot buy elsewhere.

So—Buy SCHOONMAKER because you buy the FINEST in DEPENDABLE DIESEL POWER.

America's largest source of New and Remanufactured Diesel Power

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SCHOONMAKER CO., INC.

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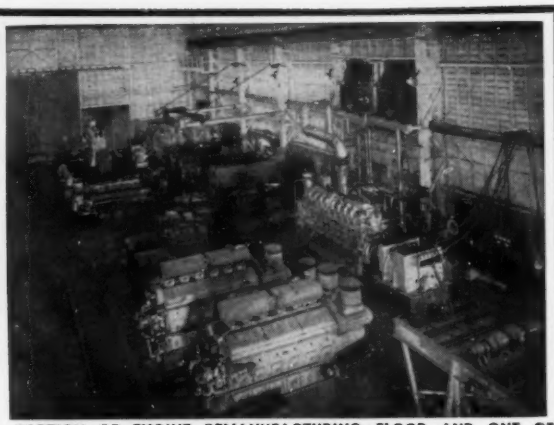

PORTION OF ENGINE REMANUFACTURING FLOOR AND ONE OF THE ENGINE TEST STANDS AT OUR SAUSALITO, CALIF. PLANT

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1180	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
600	General Motors	12-567	900	600
*500	General Motors	8-278A	750	720
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*400	Ingersoll-Rand	S-8	600	720
*400	Sterling	VDS-8	600	1200
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	80	240	600
150	Fairbanks Morse	338-17	225	300
*150	Worthington	CC-4	225	450
150	Ingersoll-Rand	S	255	600
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

ALTERNATING AND DIRECT CURRENT UNITS
STANDARD AND SPECIAL VOLTAGES AS REQUIRED
*—indicates NEW unit.

ONE YEAR GUARANTEE!

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Cyclotherm—50 HP—125 Lb Heavy Oil
Clayton—50 HP 150 Lb—Light Oil & Gas
Cyclotherms—Superiors—Powermasters
Ames—Steamasters—10-15-50 HP
Titiusville Scotch Heating Boiler—with burner 21250 sq. ft
New Frederick Stoker for 450 HP Boiler Cap 8000 Gal Gem Lined Hot Water Tank
125 HP 125 Lb Economics
750° Deg.—1,600,000 B.T.U.—125 Lb
International—Dowtherm—Boiler

BOILER & EQUIPMENT CO.
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COMPLETE BOILER PLANT

INCLUDING

B&W type H-3 Sterling #14 Boiler, 250 HP with stoker, flow meter, combustion control, piping, valves, electrical equipment, etc. Also, steel stack, breeching, feed water heater and boiler feed pump.

All new summer 1946
Address inquiries

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BRONZE VALVES FOR SALE

36" bronze Chapman valves—30 pound pressure.

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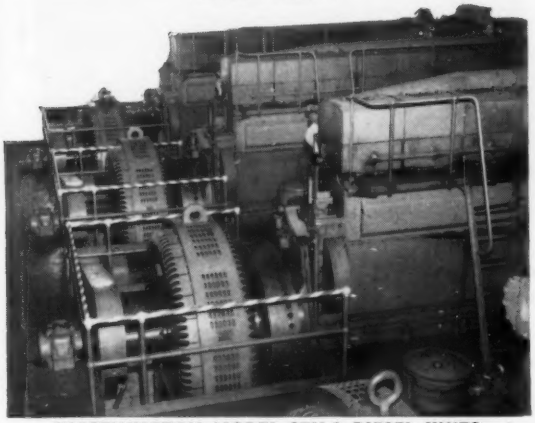
Everglade 4-4511

Special Offering

4240 KW DIESEL GENERATOR PLANT

HEAVY DUTY • SLOW SPEED • MODERN DESIGN

(ACTUAL PHOTO)



WORTHINGTON MODEL SEH-8 DIESEL UNITS

LATEST TYPE—CURRENT MODEL PRACTICALLY NEW

CAN BE INSPECTED AND TEST RUN . . . CONVERTIBLE FOR DUAL FUEL OPERATION . . . WILL BURN HEAVY FUELS . . . ONE YEAR GUARANTEE

3—1180 KW WORTHINGTON MODEL SEH-8 DIESEL UNITS

ENGINES: Each rated 1685 BHP at 360 RPM turbocharged having 8 cylinders arranged vertically in-line, 16" bore, 20" stroke, 4 cycle, solid injection.

GENERATORS: Westinghouse each rated 1180 KW, 1475 KVA for 2400/4160 or 480 Volts, 3 phase, 60 cycle service.

SWITCHGEAR: Metal-clad type manufactured by Westinghouse with draw-out type air circuit breaker.

50 CYCLE RATING 984 KW AT 300 RPM

UNIT AUXILIARIES: Each unit complete with filters, strainers, pumps, gauge board, pyrometer, thermocouples, lube oil cooler, jacket water cooler, cooling tower, exhaust muffler, intake filter silencer, expansion tank, fuel day tank, flexible piping for intake and exhaust and all station piping, flanges, valves, gauges and fittings for intake, exhaust, water, lube oil and fuel oil systems.

ALSO

1—700 KW Worthington diesel unit with same auxiliaries and accessories as above.

This equipment affords you a rare opportunity to procure complete, modern, latest design diesel units at substantial savings. It represents an offering of heavy duty slow speed diesels which cannot be duplicated by anyone in the diesel field.

ACT TODAY—PHONE, WIRE, OR WRITE FOR FULL DETAILS

Other Modern Diesel Sets from 2000 KW to 15 KW in STOCK—All Owned and Offered Exclusively by "America's Largest Source of New and Remanufactured Diesel Power"

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PLANTS AT EDDYSTONE, PA., JERSEY CITY, N. J., SAUSALITO (S.F.), CAL.

DIESEL GENERATOR SETS

3—650 HP Alco 6 cyl. 514 RPM supercharged. 400 KVA 3/60/440 volts. Complete plant. New 1943.

3—300 HP Buckeye 6 cyl. 600 RPM 4 cycle. 200 KW Ideal 3/60/480 volts generators. Complete plant. New 1947.

MISSISSIPPI VALLEY EQUIPMENT CO.

507 Locust St. St. Louis 1, Mo.

DIESEL ENGINES
Marine Stationary

GENERATORS
All sizes from 10 HP — 2000 HP

ALJON ELECTRIC DIESEL CO.

904-10 Pacific St. B'klyn 38, N. Y.
STerling 3-6515 Cable: ALJONDIS

ELECTRICAL EQUIPMENT

REBUILT N.I.S.A. STANDARDS

AC Motors — 3 phase 60 cycle

HP	Speed	Make	Wdg.	Type & Disc.
500(3)	1800	West	Syn. 2200 V.	PedBrgW/Exc
450	1800	AC	SC 2200 V.	AW-SB
350	1800	AC	SC 2200 V.	AW-SB
300	1800	West	SC	CS-TEFC Exp. Pr.
150(2)	900	GE	SC 2200V	KF-558
150	1800	GE	SR	M-6328 TEFC
150	720	Al-Ch.	SR	AR HOIST
150	750	GE	SR (25 cy)	IM
125	1200	AC	SR	ARY-BB
125(3)	900	West	SC 2200V	CS-856-C
100	720	West	SR	CW-513
100	900	GE	SR	MT-SB
100	700	West	SC	CS-SSB
100	725	Al-Ch.	SR (25 cy.)	ARY-3 Brg.
100	900	GE	Syn 2200 V.	TS-DC Exciter
75	3600	GE	SC	K-444-8
75	900	West	SR	CW-725C
75	600	GE	SR	IM
75	600	GE	SC 2200 V.	KT-558
60	1200	West.	SC	CS505 Spl. Pr.
60(3)	1200	Al-Ch.	SR	ARY-505 BB
60	720	West	SC	CS754 Spl. Pr.
50	1800	FM	SR	HV-BB
50	1200	GE	SR	MT-336
50	720	CW	SC	SC
50	600	CW	SR	SR
40(2)	1200	Rel&West	SC	Fr. 445-RB
40(2)	1200	AC&Rel	SC	TEFC-BB
40	900	West	SR	CW
40	720	AC	SR	ANY
30(3)	1800	AC	SC	ARZ-TEFC
30	1200	AC	SC	ARZ-TEFC

SPECIALS

2—333 KVA Penn. Transformers OISC 1/60—13800/2300. 1—500 KVA Trahs. West'hse Type ASL, 5% Imp. 13800/480 volts 75° Air Cooled. 2—150 KW West. M-G Sets 275 V. DC 3/60/2300 AC. 2—56RZ Falk Motoreducers 125 RPM 50 HP Class II. Hundreds other motors and electrical items in stock. Large stock new motors to 150 hp & Gearheads to 30 hp at rated discount —Freight allowed. **SEND US YOUR INQUIRIES.**

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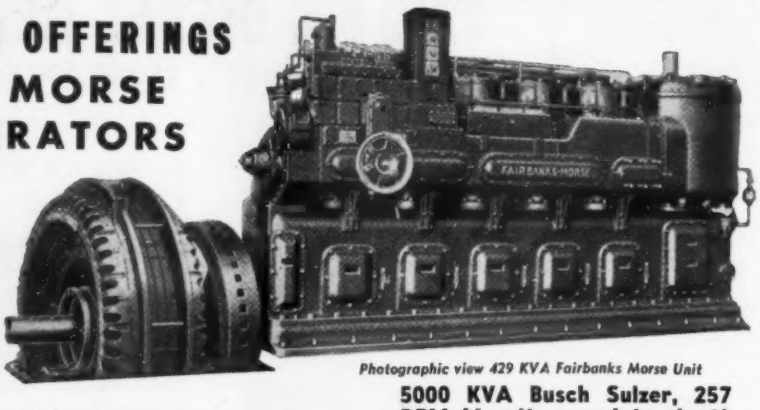
SPECIAL BARGAIN OFFERINGS
FAIRBANKS MORSE
DIESEL GENERATORS

Complete Installations

500 HP Fairbanks Morse Diesel engine Model 33-F-12, 5 cylinders, 400 RPM. 12" bore, 15" stroke direct connected to a: 429 KVA—343 KW, 80% PF, F. M. generator 3/60/2400 volts. *LIKE NEW. INSTALLED 1948.*

690 HP Fairbanks Morse Diesel engine Model 33-E-14, 6 cylinders, 300 RPM, 14" bore, 17" stroke direct connected to a: 592 KVA—473 KW, 80% PF, F. M. generator, 3/60/2400 volts. *EXCELLENT CONDITION INSTALLED 1949.*



Photographic view 429 KVA Fairbanks Morse Unit

111 KVA (2) Fairbanks Morse 300 RPM, 3 phase, 60 cycle, 2400 volts.

250 KVA Buckeye, 450 RPM, 3 phase, 60 cycle, 2400 volts. EXCEPTIONAL BARGAIN.

5000 KVA Busch Sulzer, 257 RPM (6 units complete plant) 3 phase, 60 cycle, 2400 volts.

3750 KVA General Motors (3 units complete installation) 720 RPM, 3 phase, 60 cycle, 2400/4160 volts.

375 KVA General Motors, Model 8-268A, 1200 RPM, 3 phase, 60 cycle, 440 volts.

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Rebuilt and Guaranteed Electrical Equipment

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AIR COMPRESSORS

I-R 50 HP, 2 STAGE, MODEL 50T

GEAR HEAD MOTORS

220/440/3/60-BALL BEARING, PAR. SHAFT

QUAN.	MFG.	HP	INPUT	OUTPUT	FRAME	SIZE	DISC.
30	G.E.	7½	1750	580	284	5306	TEFC
7	Link Belt	20	1750	74.4	364	DM-70	TEFC
5	G.E.	25	1750	352	365	KR	TEFC-XP
6	G.E.	40	1750	561	405	4.WL	TEFC
7	G.E.	60	1750	427	445	4.WL	TEFC

SQUIRREL CAGE MOTORS

150 HP, G.E. 600 RPM, 220/440/3/60 PED. BALL BRG.

50 HP, G.E., 900 RPM, 220/440/3/60 XP-1D, K505S

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Trading Corporation

1017 PAPIN, ST. LOUIS 11, MO.
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MOTORS · MG SETS

All guaranteed for one year.

Qty.	HP	Make	Voltage	Speed
26	1500	West.	525/600	600 RPM
32	1500	Al. Ch.	525/600	675 RPM
4	1200	Al. Ch.	525/600	650 RPM
2	900	Elliott	230	300/195 RPM
3	800	West.	525/600	600/900 RPM
1	650	Cr. Wh.	230	475/720 RPM
1	500	West.	230	250/500 RPM
1	400	G.E.	230	480/360 RPM
12	3000	West.	525/600	600 RPM
7	400	Elliott (new)	230	400/800 RPM
5	400	West. (new)	230	375/750 RPM
2	350	Cr. Wh.	230	400/800 RPM
1	280	Cr. Wh.	230	500/750 RPM
1	200	Cr. Wh.	230	375/750 RPM

All motors designed for mill reversing service.
Smaller sizes also in stock.

Motor Generator Sets in Stock
100—2000 KW Capacity

All of above is modern late type equipment remanufactured & tested by our engineers.

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PRESSURE & STORAGE TANKS

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6—10,000 & 20,000 GAL STORAGE
2—35,000 GAL. 60# W.P. 11'x54'
5—17,300 GAL. 85# W.P. 8'x45'
42,000, 120,000, 240,000 GAL. STORAGE
8—10,000 GAL. RAILROAD CAR TANKS

LESTAN CORP., ROSEMONT, PENNA.

DIESEL GENERATOR UNITS

Two 219 KVA Buckeye, 3/60/480-240 volts. Good as new; seen operating.

HRT BOILERS

Two 250 HP Erie City 150#. Four yrs. service.

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18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

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2457 WOODWARD AVE.
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STEAM — ELECTRIC — HYDRO — DIESEL

"Export Orders Carefully Executed"

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O'Brien Offers—

MOTOR GENERATOR SETS

2—1500 KW Westinghouse 275 V D.C. 514 rpm with 3/60/13200 V. Synch. Mtr. drive.
1—100 KW West SK Comp'd 125 V., 150 HP West syn. 3/60/440/1200 rpm.
1—500 KW Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels.
1—300 KW West. 3 wire 125/250 Volt 1200 RPM Generator (1938 year). Can furnish with suitable motor. Advise Requirement.
2—250 KW Burke 125 V. 435 KVA Syn. M.D. 3/60—any voltage
1—150 KW G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels
100 KW Electro Dynamic 200 V. 3/60/220/1200 B. Brg. Sq. Cg. Sep. Excited.
1—100 KW Al. Ch. 250 V. 1200 RPM 150 HP. Syn. Mtr. 2/60 or 3/60 any voltage.
1—75 KW Burke 250 V. 900 RPM 113 H.P. Burke—Syn. M.D. 2 or 3 ph, any voltage.
1—62½ KW 125 volt Hertner, 1200 rpm, 100 HP Sq. Cg. 3/60/220
2—50 KW GE 500 Volt DC, 75 HP, 3/60/40/1200 RPM.
Smaller Sizes and Types—Advise Requirements

DIESEL GENERATOR SETS

3—1250 KVA GM 16-567 3/60/2300 Portable Complete
750 KVA GM 12-567, 3/60/2300
1—625 KVA Cooper Bessemer, 3/60/480/720 rpm
375 KVA GM 8-268 Diesel 3/60/440
300 KW GM 8-268 Diesel 125/250 V. D.C.
187 KVA GM Twin Diesel 3/60/220 New
125 KVA Waukesha Diesel 3/60/220-440
100 KW Buda Diesel 250 V. D.C.
100 KVA Murphy Diesel 3/60/220-440
65 KVA Buffalo Gas 3/60/220
56 KVA Climax Gas 3/60/220
45 KVA Chrysler Diesel 3/60/220
30 KVA LeRoi Gas 3/60/220
25 KVA LeRoi Gas 1/60/120/240
20 KW Hercules Gas 110 volt D.C.
18.75 KVA Hercules Diesel 1/60/120/240

BOILERS

1—25000# Foster Wheeler 250 Lb. W. T. Package Oil & Gas Comb. New
1—50,000# Erie Stoker New 160 psi
1—300 HP Keeler CP 300 lb. Oil
1—250 HP Ames Package type (1948) 150 psi oil fired
1—250 HP B & W 250 lb. 1948
2—200 HP Springfield Sec. Hdr. 400 psi.
1— 25 HP Dowtherm Vaporizer

ELECTRIC MOTORS

QU.	HP	Make	Type	Volts	Speed
1	1500	Al. Ch.	sl. rg.	2300	514
1	1000	G.E.	K	2300	1800
1	1000	West.	CW	2300	450
1	700	West.	CS	2300	1800
1	500	Al. Ch.	Syn.	2300	212
1	500	AC	ARX	2300	1800
1	500	West.	CS	6600/2300	514
1	450	A.C.	ANY	2300	600
1	400	West.	CW	440	514
1	400	G.E.	Syn.	2300	450
3	3500	G.E.	IM	2300	120
1	350	G.E.	MT18	2300	400
2	200	G.E.	KT559	2200	1200
1	200	West.	CW	440	1800
1	200	G.E.	IM	440	600
1	125	West.	Syn. 3 brg.	550	600
2	100	G.E.	KT352	220/440	1200
1	50	West.	CS	440	3600
1	50	West.	CS	440	1200

TURBO GENERATORS
Philadelphia Stock

1—2500 KVA West. Cond. New 1936. 3/60/2400—300 psi Surf. Cond.
1—1250 KVA DeLaval Non-Cond. 3/60/2300. New 1940 240 psi 50 lb. B.P.
1—938 KVA GE-Terry Aut. Extr. 3/60/480 150 psi. 20 lb. B.P. Surf. Condenser 1934
1—780 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Cond. 180 PSI 35 lb. B.P. New 1936.
1—187 KVA West. Non-Cond. New 1930 3/60/440 110 psi 10 lb. B.P.
1—94 KVA Worthington Non-Cond. 3/60/220 140 psi 5 lb. B.P.
1—50 KVA 1200 rpm Century generator (New 1949) Dean Hill Non-condensing turbine
1—75 KW G.E. Non-Cond. D.C. 125 volt.

AIR COMPRESSORS

1—1600 cfm IR PRE-2 Syn. Mtr. Dr. 3/60/2300—100 psi.
2—1300 cfm IR-PRE-2 3/60/2300—100 psi
1—1000 CFM Chicago OCE Syn. Mtr. Dr. 175 HP 3/60/2300.
1—978 CFM Sullivan 13x13x8, 45 psi.
1—670 CFM Chicago OCE Syn Mtr. Dr. 3/60/2300
2—660 cfm I R-XRE 3/60/480—100 psi
1—396 CFM Sullivan WL60 125 psi Direct Drive 75 HP 3/60/440
1—215 CFM Penna 3A, 70 psi—V-Belt
1—368 CFM Chi. NSB, 12x10, 100 psi.
1—371 CFM Schramm 7¼x5x4, 100 psi
1—173 CFM Chicago NSB 100 psi

OISC TRANSFORMERS

Qu.	KVA	Make	Pri. V.	Sec. V.	Phase
3	2000	G.E.	13200	230/460	1
3	1000	GE	13200	2300	1
1	1100	West.	4160	440	3
3	667	Al. Ch.	33000	2300	1
3	500	West. Dry	33000	2300	1
3	500	West.	22000	460	1
1	500	Gregory	4160	440	3
3	500	GE	13200	2300	1
3	400	GE	2400	480	1
3	333	West. Dry	2400	480	1
3	333	West. (1945)	33,000	480	1
3	333	Pitts.	33000	2300	1
3	333	G.E.	13800	240/480	1
2	250	West. Dry	13800	230	1
3	150	West	2300	230/115	1
3	150	Dry	2300/4160	230/460	1
3	100	Dry	2300/4160	230/460	1

1—New O'Brien "Red-Line" 750 KVA OISC Transformer 13,200/13,800 v. pri., 480 v., sec., 3 ph.
3—333 KVA New O'Brien Red Line O.I.S.C. Transformers 4160 V primary 480 V secondary ea. single ph. 60 cyc.

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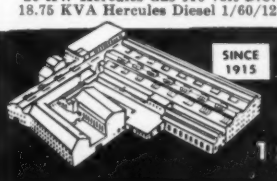

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New and used equipment recently released from service by a number of electric and gas utility companies

POWER PLANT EQUIPMENT
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TRANSMISSION LINE MATERIALS

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APPARATUS EXCHANGE
Two Rector St., New York 6, N. Y.

M-G SETS! MOTORS!

1—500 KW 24 V. D.C., Whse. M-G Set, 900 RPM, Syn. Drive, 3/60/2200, Ser. 4979926 with magnetic reduced voltage starter.
1—200 KW, 125 V D.C., Type PED, Ser. 576881, E-M Set, 900 RPM. Syn. drive, 3/60/2300 (or 4160).

TURBO-GENERATOR

1—750 KW, Elliott AC Generator, Frame 3232, 3600 RPM, 3/60/480. Elliott Turbine, inlet 200# ga., 112 deg. F superheat. 28" hg. vac. exhaust. Complete with accessories.

SYNCHRONOUS CONDENSER

1—1000 KVA, Allis-Chalmers, 3 phase, 60 cycle, 2300 volts, 600 RPM.

SYNCHRONOUS MOTORS

1—200 HP, F-M, 300 RPM, Type TZO, Frame 5
1—200 HP, E-M, 900 RPM, Type PED, 2300/4160 V
1—150 HP, G.E., 277 RPM, Type ATI, 2300 V

SQUIRREL CAGE MOTORS

Amt.	HP.	Speed	Make	Type	Frame
3	250	600	G. E.	KT568(2200V.)	
1	150	1800	Whse.	CS(2200V.)	8718
1	150	1800	A-C		
1	150	900	G. E.	I-K(2200V.)	15
1	100	1800	Whse.	CS	663C
1	100	1200	Whse.	CS	752C
1	100	900	G. E.	MT356 Slpr.	
1	100	900	A-C		2300V.

NEW MOTOR STARTERS

1—Size 3, Whse. Combination, circuit breaker, Nema 1, 3/60/440
21—Size 2, G.E. Combination fusible, 60 and 100 amp, 3/60/220, CR7003A42C
88—Size 1 Whse. life line, 3/60/220
7—60 thru 200 HP EC&M, 3/60/2300 Size 10 Magnetic Compensators

GEARMOTORS

1—20 HP, 400 RPM, Westinghouse ID-XP
1—10 HP, 88 RPM, Master, parallel shaft output
2—10 HP, 55 RPM, Whse. Fr. 324, parallel shaft output
1—7½ HP, 11 RPM, Whse. Fr. 284Y, TEFC
1—5 HP, 155 RPM, U.S. Fr. 254, parallel shaft output
18—Cleveland right angle worm gear reducers, rated 5 HP-1150 RPM, 7½ HP-1750 RPM, 6-1 ratio, Series 215, Size 50 RT, Class 1
4—Ratio 10-1, Series 25F—ditto

NEW INGERSOLL-RAND MOTOR PUMPS

Amt.	GPM	HD.	Type	Motor Encl.
2	140	90	2—ORVL-7½	TEFC
2	154	90	2—ORVH-5	XP-1-D
1	1500	35	5—KVL-25	XP-1-D
1	1½ x 1½		AC, SSL	XP-1-D

OISC-TRANSFORMERS—Single Phase

Amt.	KVA.	Make	Type	Volts
9	37½	G.E., Moloney, Whse.		2400-240/480
2	50	Wagner	HEX	4000-1328/2300Y
3	75	Whse.	S	2400/4160-480/240
3	150	Moloney	HE	4000-230/460

PARTIAL LISTINGS—10,000 OTHER MOTORS IN STOCK—SLIPRING—SYNCHRONOUS.
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- TRANSFORMERS
- CONTROLS
- COMPRESSORS
- HOISTS • PUMPS
- SWITCHBOARDS

SLIP RING MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 volts or higher)

HP	Make	Type	Speed
2000	*G. E.	MT-12	600
2000	*G. E.	MT-30	287
1500	*G. E.	MT-30	240
1250	*West.	CW	600
1000	*West.	CW	250
700	*A. C.	ANY	720
500	*G. E.	IM	3600
500	*G. E.	MTP	1800
500	*G. E.	MT	450
500	West.	CW	350
400	A. C.	3-brg.	450
400	*G. E.	MT412	450
350	West.	CW	900
300	*G. E.	IM13A	1800
300	*G. E.	MT410	450
250	West.	HF15H	600
200	G. E.	IM15	1200
150	G. E.	MT549 BB	1800
125	*G. E.	MT549	1800
125	G. E.	IM15A	600
100	A. C.	ANY	900
100	G. E.	IM13A	1800
100	G. E.	IM15A	450
75	Northw'n	HW50	1800
75	G. E.	MT347	1200
75	G. E.	MT356	900
75	G. E.	IM	720
75	G. E.	IM14	600
60	West.	CW762C	900
50	G. E.	IM11A	1800

SQUIRREL CAGE MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 volts or higher)

HP	Make	Type	Speed
1750	*G. E.	K	3600
1000	*G. E.	K6347S	1800
750	*A. C.	TEFC	1800
750	*G. E.	KT	720
700	G. E.	FT	3600
500	*A. C.	6316SW	1800
400	*G. E.	KF559	3600
300	*West.	CS	3600
250	*L. Allis	OGX148	720
250	G. E.	IK	600
200	*G. E.	FT549Y	3600
200	A. C.	ARW	3600

AIR COMPRESSORS

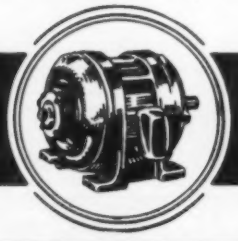
Sizeo	Make	Type	PSI	Displs
10x11	Worth.	HB	100	294
11x12	Worth.	HB	100	426
12x13	Worth.	HB	125	460
20x12 by 14	Sullivan	WN4	100	2032

If you don't find what you need wire, write or phone for complete stock list.

M. G. SETS

KW	Make	AC	DC
2400	West. (3-u.)	4800	525
1000	West. (3-u.)	11000	137/275
500	AC-West.	2300	250
450	G. E. (3-u.)	2300	125/250
400	A. C.	2300	120/240
300	Cr-Wh.	440	250
200	G. E.	440	550
200	West.	2300	275
200	G. E.	440	600
150	G. E.	2300/440	250
150	G. E.	2300/4000	125/250
150	G. E.	440	275
125	G. E.	440	300
125	West.	440	250
100	G. E. (25 cy.)	440	125
100	G. E.	2300	250
100	Ridgway	2200	275
100	West.	220	125
100	Elec. Machy.	220	125
90	G. E.	220	250
90	G. E.	440	60
75	Reliance	2300/440	250
75	G. E.	440	125
60	A. C.	2300	110
50	G. E.	440	250
40	A. C.	220	125
35	West.	2200	125
30	G. E.	220/440	250
25	Cr-Wh.	440	125
20	G. E.	440	250
20	Bogue-GE	550	250
20	Bogue-GE	220/440	125

PHONE: CANAL 6-2900



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1—500 KW, Worthington, 2400 V, 360 RPM.

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107 CFM 7—7 x 7 Ingersoll FS-I STEAM
122 CFM 7 x 7 Ingersoll ES-I 20 HP
142 CFM Ingersoll Semi-Portable 25 HP
160 CFM 1R-Worth Portable
165 CFM Smith 110SR Semi-Portable, 25 HP
167 CFM 10 x 5 Ingersoll Vacuum Pump—7½ HP
195 CFM 8—9 x 9 Worthington HS STEAM
210 CFM Worthington (GAS or DIESEL) Port
211 CFM 9 x 9 Chicago T-B 30 HP Elec.
279 CFM 11—10 x 11 Worthington HS Steam
294 CFM 10 x 11 Worthington HB 50 HP Elec.
315 CFM Worthington (GAS or DIESEL) Port
434 CFM 14 x 7 Ingersoll Vacuum Pump—15 HP
402 CFM 13½/9 x 10 Chicago O-CB Duplex 75 HP Elec
600 CFM Worthington (DIESEL) Portable
628 CFM 14 x 13 Ingersoll ES-I, 100 HP
720 CFM 18 x 7 Worthington HEV Vacuum Pump 25 HP
868 CFM 17/10 x 12 Chicago O-CB Duplex 150 HP Elec.
1184 CFM 22 x 9 Chicago T-VB Vacuum Pump 40 HP
1633 CFM 24 x 11 Chicago T-VB Vacuum Pump 60 HP

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3—3333 KVA 66000 to 33000 & 13200 v.
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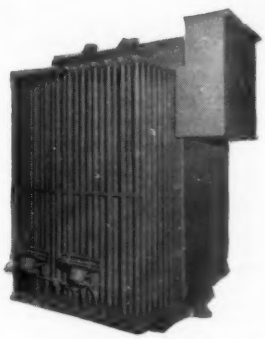
3— 500 KVA 38100/66000Y—2300 v.
3— 500 KVA 33000 v.—2300 v.
4— 500 KVA 13200 v.—2300 v.
4— 200 KVA 33000 v.—2300/4160Y
5— 200 KVA 13200—2300/4160Y
1— 200 KVA 12000—2300/4160Y
3— 200 KVA 7620/13200Y—2300
1— 150 KVA 66000—2300/4160Y
14— 100 KVA 33000—2300/4160Y
9— 100 KVA 13200—2300/4160Y
6— 100 KVA 7620/13200Y—2300/4160Y
3— 75 KVA 460—120/240
3— 75 KVA 2400—230/460
2— 50 KVA 60000—2300 v.
1— 50 KVA 6600/11400Y—2300
3— 50 KVA 13200Y—2300 v.
1— 25 KVA 13200Y—240/480
1— 25 KVA 7200/12470Y—240/480
3— 25 KVA 400/4160Y—120/240
3— 25 KVA 2400—230/460
8—15 KVA 67—5 KVA
62—10 KVA 26—3 KVA
71—7½ KVA 15—1½ KVA



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11500 to 480 V — Indoor — Taps

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2—60/120—5 A. 37 KV G.E. C.T.

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1—7½ KVA 230/460-115/230 v. 1/60 cy. Moloney Dry Type.
8—6.6 amp Const. Current 2 KW 240 v. General Electric type RO
3—Ignition Transformers 115 v. 60 cy. 200 VA France Co.
8—Novulux Controllers—G.E. CR-7841-GB2 230/2300 v. 120 v. 60 cy. Line amps. 100/50

WE WILL REWIND ANY OF THESE TRANSFORMERS TO YOUR SPECIFICATIONS

TAMPA ARMATURE WORKS INC.
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DIESEL GENERATOR SETS

3—75K2A C.W., 120/208 V., 3 Ph., 1200 RPM. V Belt. to KRUPP. 3C1/L., 2 cy. solid injection omplete.

TRANSFORMERS—60 Cycle

Qu.	KVA	Make	Type	Ph	Voltages
1	1000	G. E.	Auto	3	4150x2400
2	750	G. E.	HT	3	4150x120/240
2	750	G. E.	H	1	4800-120/240
1	500	Kuhl.	OISC	1	4150x2400
2	400	Pitts	OISC	1	4800/4150/2400 x240/480
3	333	Whse.	OISC	1	2400x575
1	333	G. E.	H	1	13200x220/440
5	300	G. E.	H	1	13200x440
4	200	G. E.	H	1	13200x440
1	200	G. E.	HT	3	2400x240
2	150	Pitts.	ODSC	1	240x120/240
2	50	G. E.	H	1	4800x120/240
3	40	A. C.	H	1	230x120/240
1	25	G. E.	H	1	460x120/240

SLIP RING MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
2	500	G. E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	600	CW	440
1	200	Whse.	600	CW	440
1	200	G. E.	600	MT	440
3	150	A. C.	1800	AY RW	2300
1	100	G. E.	1800	IM	220
1	100	G. E.	600	IM	440
1	75	G. E	600	IM	440
1	60	G. E	1800	MT	220

DC, 230 VOLT MOTORS

Qu.	H.P.	Make	Speed	Type
1	300	G. E.	1200	MPC
2	150	C. W.	900	WP
1	125	G. E	1700	RC
2	75	C. W.	900	WP
1	30	C. W.	700	CM
1	35	G. E.	860	RC
1	25	Whse.	835	SK

WESTINGHOUSE M.G. SET

1000 KW, 600V D.C., 2400/4160V, 720 RPM, 3 Ph., 60 Cy., 7 PF Syn. Motor. Direct Connected Exciter, Motor Driven Rheostats, Switch Boards, all for full automatic operation.

SQUIRREL CAGE MOTORS

Qu.	Make	Speed	Type	Volts
150	G. E.	720	KT	440
125	G. E.	3560	KF	2300
100	G. E.	1200	FTR	220
75	Ideal	1200	AT	220/440
60	G. E.	1200	KT	220
50	G. E.	3560	FT	220
50	G. E.	600	KT	440
40	G. E.	3550	FT	440
30	G. E.	600	KT	440

MOTOR GENERATOR SETS

Qu.	KW	Make	Speed	DC	AC
1	1000	G. E.	514	600	2300/4150 Syn.
1	1000	Whse.	720	600	2300/4150 Syn.
1	1000	Whse.	720	275	2300/4150 Syn.
1	300	C. W.	1200	230	3-unit 2400/4150SR
1	300	G. E.	1200	230	2400/4150SR
1	200	Whse.	900	250	2300/4150 Syn.
1	150	C. W.	1200	230	440 SC
1	150	3 Unit G. E.	1200	125/250	2300 Syn.
1	150	Whse.	600	125	4150 Syn.
1	125	C. W.	1200	125	2300 S.C.
1	100	G. E.	900	250	2300 Syn.
3	60	G. E.	1200	125	208 Syn.
2	30	G. E.	1200	125	440 SC

SYNCHRONOUS MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
1	300	El. Mach.	720	TEFC	2200
3	200	Whse.	720		4150
1	175	G. E.	720	ATI	2300
1	150	G. E.	720	ATI	2300
1	150	G. E.	1800	TS	220
1	150	Whse.	900	ISIG	220

OIL CIRCUIT BREAKERS

3—600 AMP. G. E. FKR-55-20, 15,000 V. 3 P. 100,000 KVA, SOLENOID OPER.

1—600 AMP. G. E. FK-143, 15,000 V. 3 P. 50,000 KVA, Manual with Disconnects, Metal Clad Enclosure.

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Boilers	Motor Generator Sets	Oil & Air Circuit Breakers
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WE BUY SURPLUS FUSES

USED 35 TON BRIDGE CRANE

75' span with 5 ton aux, 25' lift. Cab type 3/60/220 V. A.C.—used approx. 2 yrs. Mfg. Northern—*excellent condition.*

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60 HP 125# Erie City Economic Boiler
1000 KW, 720 RPM Belted Generator NEW
1000/500/150 KW Motor Generator Sets
312/120/75 KVA Engine Generator Sets
125,000 Gallon Water Tank & Tower
6'x50' Louisville Rotary Dryer
150 HP, 720 RPM Motor w/starter
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2—250 H.P., 170 KW, 400 rpm, 5 cyl. Worthington
1—125 h.p., 100 KW, 600 rpm, Columbia Electric Generators and Switch Board
In excellent condition. Make us an offer.
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FOR SALE

1 complete Fairbanks Morse plant—3—225 HP, 1—150 HP Model 32E14 with 185 and 156 Kva Generators—240-480 volts—3—360 HP Model 32E Fairbanks, 300 Kva Generators.

Other units 120 to 700 HP—Fairbanks Morse parts I buy, sell or trade.

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One Kewanee 125 HP, serial No. 386 equipped with North American Dual Oil Burners and Fan. Now in operation until about June 1, 1954.

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380 HP • 1800 R.P.M.
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General Motors 6-71 Twin Diesels used less than 25 hours—priced for quick sale—inspection invited.
CRYSTAL MOTORS
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TURBINE GENERATOR UNITS

7500 KVA G.E. condensing, form J, 5 stage, 200 lbs. 3 phase 60 cycle 2300/4000 volts.

5625 KVA West. condensing, type CW, 150 lbs., 3 phase 60 cycle 2300 volts.

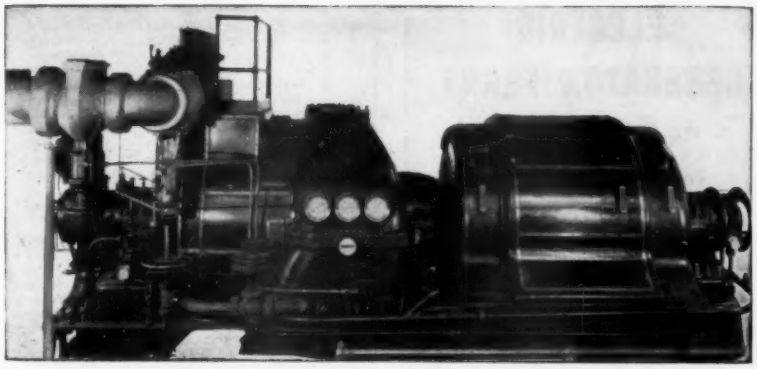
3750 KVA G.E. condensing, form G, 4 stage, 150 lbs., 3 phase 60 cycle 480 volts.

2500 KVA G.E. noncondensing, form A, 3 stage, 150 lbs. initial, 15 lbs. exhaust, 3 phase 60 cycle 480 volts.

1875 KVA G.E. condensing, type F, 10 stage, 150 lbs., 3 phase 60 cycle 480 volts.

1250 KVA G.E. noncondensing, form B, 1 stage, 125-150 lbs. initial, 5-15 lbs. exhaust, 3 phase 60 cycle 2300 volts.

1250 KVA G.E. condensing, form E, 3 stage, 150 lbs., 3 phase 60 cycle 2300 volts.



3000 KW NONCONDENSING TURBINE GENERATOR UNIT

3000 KW 80% P.F. 3750 KVA General Electric generator, 3 phase 60 cycle 480 volts direct connected to 3000 KW General Electric noncondensing turbine, type R, 8 stage. 150# initial pressure, 15# exhaust back pressure, 3600 RPM.

The above turbine generator units are in excellent condition. They are still installed and complete with all auxiliaries as in operation.

Write, Wire or Phone For Further Details and Prices.

INTERNATIONAL POWER MACHINERY CO.

UNION COMMERCE BLDG. Telephone: MAin 1-9514 **CLEVELAND 14, OHIO**

MOTORS • GENERATORS • TRANSFORMERS

3 PHASE 60 CYCLE 220/440 VOLT

HP	Make	Type	Speed
10	F.I.M., 2 Speed	H-12B	600/1200
10	G.E.	KT-502	860
10	Cr. Wh., BB	SC-ALH 365	865
10	Allis Ch.	AR	1200
10	G.E.	KT-300	1200
10	G.E.	K-326	1200
15	West. New, Vert., BB	CW-404	900
15	G.E.	IK	700
15	G.E.	KT-312	900
15	G.E.	K-512	900
15	Cr. Wh.	SC	900
15	U.S., BB	FRB-482	1200
15	Reliance	IH	1200
15	G.E.	K-326	1800
15	L. Allis, TEFCCB, Ex. Pr.	EX-364	1760
15	G.E., Special	KF	3460
15	G.E., Var. Speed	IK	1800/600
20	West.	MS	900
20	G.E.	I	900
20	Wagner	BP-18T	1140
20	West.	CS	1150
20	West., New, BB	CS-365	1170
20	L. Allis, TEFCBB, Ex. Pr.	ES-365	1800
25	G.E., Slip Ring	I-M	685
25	G.E., New	K-405	900
25	G.E.	IK	1200
25	Allis Ch.	AR	3600
30	Wagner, Slip Ring		1200
30	G.E., Slip Ring	MT-523	1800
35	West., Slip Ring	CW-785	585
40	Cr. Wh.	1210	685
40	Lincoln	IM	720
40	West.	CS	1160
50	West.	CS	900
50	G.E.	K-504	1200
50	F. Morse	12-B	1725
50	F. Morse	H	1750
50	Ideal, New, TEFCCB	A-B	1800
60	West., TEFCBB, Ex. Pr.	CS-607	875
75	West., Slip Ring	CW	900
75	G.E.	KT-356	865
75	F. Weischel, Synch.	26Y-RN	1200
100	West, Slip Ring	CW	435
150	G.E.	KT-5585	875
200	G.E., Slip Ring	IM	600
200	G.E., Synch	2300 volt	225
350	G.E., Synch	4800 volt	225

25 CYCLE MOTOR SPECIALS

1— 40 HP Reliance TEFC BB 3/25/220/440/1500 RPM.

1— 50 HP Fairbanks Morse BB 3/25/220/440/750 RPM.

1—100 HP Gen. Elect. Type KT 553 3/25/440/1445 RPM.

1—100 HP Gen Elect. Type KT 5595 Ball Bearing 3/25/440/1465 RPM.

2—150 HP Gen. Elect. Type KT565 TEFC BB—3/25/440/750 RPM.

MOTORS

60-50-25 Cycle in Stock—All Sizes. Slipring—Squirrel Cage—Synchronous. All types of Control Equipment.

100 HP Gen. Electric Type I form K 3/60/2300/600 RPM.

100 HP Gen. Electric Type KT 356 3/60/2200/900 RPM.

125 HP Gen. Electric Type I form K 3/60/440/720 RPM.

125 HP G. E. Type KT 3/60/2300/1200 RPM.

150 HP G. E. Type KT 3/60/440/500 RPM.

150 HP Gen. Electric Type I form K 3/60/2300/900 RPM.

400 HP GEAR REDUCER

1—400 HP Nutall (Westinghouse) Type LMR-25 Single Helical Heavy Duty Reducer—6-1 Ratio at 900 RPM with High Speed Shaft Extension for Brake.

400 H.P. COMPENSATOR

400 H.P. Westinghouse reduced voltage, manually operated synchronous motor starter—Unity P.F.—3/65/2300 Volts—Complete.

55" LIFTING MAGNET

1—55" Cutler Hammer Magnet 250 Volts DC. Excellent Condition.

125 VOLT DC MOTOR

1—100 HP Crocker Wheeler 125 Volt DC 850 RPM Ball Bearing

DC CIRCUIT BREAKERS

1—1000 AMP. Condit. 2 Pole

1—1600 AMP. Condit. 2 Pole

1—1600 AMP. Westinghouse 2 Pole

1—3000 AMP. Westinghouse 2 Pole

TRANSFORMERS

1—750 KVA Niagara, New. Outdoor 3/60/2400/208Y/120

1—300 KVA Niagara, New. Non-inflammable Liquid. 3 Phase, 60 Cycle 4160 V. Prim. 480 V. Secondary, Primary Fused Cutouts, Secondary Junction Box. Immediate Shipment

1—75 KVA G.E. Dry Type 1/60/440 V. Primary 220 V. Secondary

6—50 KVA Niagara. New. Dry Type 1/60/240/480-120/240

1—20 KVA G.E. Dry Type. 1/60/480 V. Primary, 120 V. Secondary

ERIE ELECTRIC CO., INC.

124 CHURCH ST. BUFFALO, N. Y.

CL. 4758

AT AUCTION
ELECTRIC GENERATOR PLANT
of the City of Milford, Del.

To Be Sold at Auction

WEDNESDAY, MAY 19, 1954

at 1 P.M. Daylight Time

on the Premises

Westinghouse Steam Turbine Driven Generator, 3600 R.P.M., KW Rating 1250 with Allied Equipment.

Westinghouse Steam Turbine Driven Generator, 3600 R.P.M., 625 KVA with all Allied Equipment

GE Curtis Steam Turbine Driven Generator, 3600 R.P.M., 300 KW with Allied Equipment.

2 Edgemoor 361 H.P. Water Tube Steam Boilers with underfeed Stokers, Coal Conveyor, large Stock of Parts.

Westinghouse Auxiliary Generators, Ingersoll Rand 10x8 Air Compressor, Miscellaneous Power Equipment, Transformers, Pumps, Motors, Panel Board, Switching Equipment, Conveyors, Meters, Hoists, Crane, etc.

City of Milford has contracted to buy its power from Delaware P&L Co.—hence this sale at auction.

Write for Descriptive Illustrated Circular

SAMUEL T. FREEMAN & CO.

Auctioneers

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Philadelphia 3, Pa.

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4—1200 H.P. B&W Sectional Steel Header Cross Drum Boilers, 225# design pressure, Mfg. in 1924. Code. All usual accessories. Lower rows retubed in 1950. Located in N. Y. State.

2—824 HP Sterling Boilers, 1930, active certificate for 300# W.P. chain grate stokers, ELESCO superheaters, all auxiliaries, Austin, Minn.

3—600 HP, B. and W. longitudinal drum, sectional header boilers, A.S.M.E. 225# steel headers. Located N. Y. State.

2—509 HP, B. and W. Boilers, 1916, retubed 1952 209# W. P. Lawrence, Mass.

1—490# Walsh-Widener Cross Drum, Sectional Headers, 4" tubes, 1927, 450# W. P. all auxiliaries. West Point, Virginia.

1—400 HP Keeler C. P. Boiler, 1942, 160# W. P. new tubes and refractory, TODD mechanical oil burner and pump set. Overhauled, dismantled. Ready to ship. N. Y.

Complete plant consisting of:
2—20,000# pr. hr., 160# W. P., 1942, B. and W. steam generators, deaerating heater, all boiler auxiliaries. A complete plant. San Fernando, Florida.

1—310 HP Keeler C. P. Boiler, 160# W. P. 1942, pressure parts ship in one piece. Lake City, Florida.

1—250 H.P. B.&W. Sectional Steel Header Boiler, 250# W. P. All usual accessories and trim, mfg. in 1924. Location—Florida.

PACKAGE BOILERS

2—350 HP Cleaver-Brooks, 150# W. P., 1946 mfg., No. 6 oil. Location—New Jersey.

2—300 HP Cleaver-Brooks, 150# W. P., 1947 mfg., No. 6 oil. Location—New Jersey.

Miscellaneous Scotch Marine Boilers, 75 to 150 H.P. available.

A number of Self-Contained & Economic Units, 50-150 H.P., 100-200 Lbs. Pressure.

2—Detroit Roto-Spreader Stokers for 300 H.P. Boilers, nominal rating.

Combustion Engrg., Spreader Stoker complete with fan & Hogan Controls-Stoker. Designed for 600 H.P. boiler at 200% of rating, or 1200 H.P.

3—Elliot Surface Condensers, 1—900 sq. ft. 2—600 sq. ft. Located in New Jersey.

1—500 KW G.E. Turbine, 5 Stage with 625 KVA Alternator, 440 V., 600 sq. ft. Elliot super condenser.

1—300 KW. Gen. Elec. Turbo-generator set. Completely rebuilt and rewound for 220/440 V. includes switchboard and exciter. Presently boxed for export. Offered at an extremely low price.

1—15 KVA 3/60/220 V. Ideal air commr to 3 cyl. Hill Diesel engine with control panel.

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24,000 pounds per hour—4890 sq. ft.—225 pounds working pressure. Made by Combustion Engineering Co. Located West Coast.

(3) SCOTCH MARINE BOILERS

225 pounds working pressure. Approximately 17,500 pounds each, per hour.

(4) 300 KW G.M. 8-268A DIESEL GEN.

G.M. diesel generator sets—120/240 volts DC—1200 RPM—1250 amps.—8 cyl. 6½x7—with switchgear.

NEW 60 KW CUMMINS DIESEL GEN. SET

60 KW—120 volts DC

(2) 100 KW GM 3-268A 440/60/3 AC generator sets.

(1) 100 KW LORIMER 440/60/3 AC generator set.

(1) 100 KW FAIRBANKS-MORSE opposed 440/60/3 AC generator set.

75 KW WAUKESHA DIESEL GEN.

Heavy duty—totally enclosed—with built-in switchgear. 75 KW—230 volts DC. 6 cyl. Waukesha diesel, 160 HP, 1200 RPM. Radiator cooled.

(6) 300 KW TURBO GENERATOR SETS

120/240 volts DC—Joshua-Hendy turbine—250 lb. W.P. condensing. Suitable for pressures to 440 lbs. at 740 TT. Geared to 1200 RPM. 300 KW Westinghouse 120/240 volt 1250 amp. stabilized shunt generator. With switchgear. Built 1945. Excellent condition.

(1) SUPERIOR HEAVY DUTY DIESEL

510 HP at 360 RPM—5 cylinder—14½x8—type ZDSB—non-reversing—vertical—4 cycle—cold starting—mechanical injection. Engine totally enclosed. For heavy duty pumping, dredge service, power generation, textile & saw mills, etc. Excellent condition. Immediate delivery.

ELECTRIC WINCHES

50 HP—230 volts DC—built in controls—5 ton and 10 ton.

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Curtis 7-5050

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1—150 H.P. 175# H.R.T.
2—300 H.P. Keeler C.P.
2—400 H.P. 1—500 H.P.
1 Steel Stack 54" x 90' ¼ Plate

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ROCHESTER 1, NEW YORK

Explosion Proof Motor Headquarters

GUARANTEED REBUILT,

220 or 440 VOLT, 60 CYCLE, 3 PHASE, SQUIRREL CAGE and SLIP RING MOTORS:

H.P.	MAKE	TYPE	SPEED	DESCRIPTION
350	G.E.	IM-17B	600	slip ring, S.B.
250	G.E.	KT 564	900	B.B.
150	G.E.	KT 549	1800	S.B.
150	G.E.	IM	1200	slip ring, S.B.
150	G.E.	KT 564	600	B.B.
125	L.A.	FX 5055, new	1800	B.B. splash proof
100	L.A.	JA 5055, new	1800	TEFCBB
100	L.A.	FX 5045, new	1800	B.B. splash proof
100	Cr. Wh.	SC	1200	TEFCBB
100	G.E.	KT 347	1200	S.B.
100	West.	CS 607	1200	S.S.B.
100	G.E.	MT 356	900	slip ring, S.B.
100	F.M.	H-205C	900	B.B.
100	G.E.	IM	720	S.B. slip ring
100	West.	CW	600	slip ring, S.B.
75	West.	CS 504	1800	TEFCBB
75	West.	CS 445	1800	B.B.
75	G.E.	MT 343	1200	slip ring, B.B.
60	Ideal	AH 444, new	1800	S.B.
50	Ideal	A 405, new	1800	S.B.
40	L.A.	OGX 404, new	1800	drip proof, S.B.

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SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	440	Whse.	1800
600	2200	Whse.	450
500	2200/4000	G. E.	900
450	440	Whse.	514
450	440	Whse.	720
400	440	G. E.	900
300	4000/2300	Whse. (new)	600
300	2200/440	G. E.	720
300	440	G. E. (hoist)	600
300	2200	G. E.	360
300	440	Whse.	3600
250	440/220	Whse.	600
250	550/440	G. E.	1200
250	440	G. E.	600
200	440/220	Whse.	514
200	440	G. E.	450
150 (2)	440/220	G. E.	720
150	2200/440	G. E.	600
150	550/220	G. E.	720
145	4000/2300	G. E.	1800
135	440/220	G. E. (hoist)	600
125	440/220	G. E.	900
125	550/440	G. E.	1200
125	2200	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G. E.	ATI	720
375	440/220	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G. E.	TS	720
300	2200/440	G. E.	TS	1200
250	2200/440	G. E.	TS	720
250	440/220	G. E.	ATI	1200
250	2300	G. E.	TS	3600
250	440/220	Whse.	HR	277
250	2200/440	G. E.	TS	1200
250	440/220	G. E.	ATI	600
200	4150/2300	Whse.	G	1800
125	440/220	Whse.	HR	400
110	440/220	G. E.	TS	257

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2200	G. E.	FT	3600
500	2200	Whse.	CS	514
500	2200/4000	Elliot	SC	1800
500	2200	G. E.		450
400	2200	G. E.		360
400	2200/400	Whse.	CS	720
300	2200	L. Allis	FS	1800
250	2200/440	G. E.	IK	720
225 (2)	2200/440	G. E.	KT	1200
200	2200/440	G. E.	K	1200
200	440	G. E.	IK	720
200	440/220	G. E.	KT	1800
200	2200/440	G. E.	JK	600
200	2200	G. E.	KT	1800
150	440/220	Whse.	CS	900
150	2200	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440	Multi sp.	KT	1800/600
150	440/220	G. E.	IK	450
150	440/220	G. E.	KT	720
150	440/2200	G. E.	IK	514
150	2200/440	G. E.	KT	600
125	440/220	G. E.	KT (vert.)	1200
100	2200/440	G. E.	K	1200
100	220/440	G. E.	K-TEFC	720
60 (2)	2200	Whse.	CS X-pf.	1800
50 (2)	410/220	Whse.	CS-TEFC	1800
50	220	Al. Chal.	X-prf.	600/1200

A. C. GENERATORS

1—320 kva. 660 rpm 2300/440/220 V., G.E.
1—300 kva, 900 rpm, 480/220 V., G. E.
1—250 kva, 720 rpm, 2300/440 V., G. E.
1—225 kva, 600 rpm, 220/440 V., G. E.
1—200 kva, 720 rpm, 2200/440 V., G. E. (Ball brg.)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-28, 600 amp., 15,000 V., G. E., Sol. opr., draw-out.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
250	230 (2 new)	Cr. Wh.	CMC	1800
225	230	Whse.	SK	2870
200	230	G. E.	CD	750
150	230	Whse.	SK	1750
100	230	Whse.	SK	400/1200
100	230	Cr. Wh.	CMC	625
90	230	G. E.	CD	1750
80	230	G. E.	RC	600
50	230	Rel.	T	400/1200

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440/220	Syn.	250
250	Whse.	2200	Syn.	250
175	G. E.	220/440	Syn.	230
125	G. E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	sq. ca.	240/120
100	Whse.	440/220	sq. ca.	125
75	G. E.	2200/440	Syn.	125
65	G. E.	2200/440	sq. ca.	250
65	G. E.	2200/440	sq. ca.	125
45	G. E.	440/220	sq. ca.	250

TRANSFORMERS 60 Cy.

3—667 kva, Al. Chal., 22000/11000/2300 V.
1—600 kva, Standard, 13,800-2300 V., 3 ph.
3—500 kva, G. E., 22000/11000—2300 V.
3—500 kva, Whse., 66000—2300 V.
3—333 kva, G. E., 12000—2300 V.
3—200 kva, G. E., 2300—575 V.
3—200 kva, G. E., 11000—2300 V.
3—200 kva, G. E., 4150—480/240 V.
3—150 kva, G. E., 33000—2300/4600 V.
3—150 kva, Al. Chal., 2400—240/480 V.
3—150 kva, Al. Chal., 2400—240/120 V.
6—100 kva, Whse., 2400—120/240 V.
5—100 kva, G. E., 4150—120/240 V.
2—100 kva, Whse., 2400—120/55 V.
3— 75 kva, Whse., 2400—240/480 V.
3— 75 kva, Moloney, 4150—240 V.
3—50 kva, Whse., 440—220/110 V.
6—50 kva, G.E., 2403—120/240 V.

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Charges 54 cell battery at from 1 to 10 amp. rate. Operates on 115 V. 60 cy. 1 ph. Guaranteed unused war surplus in original cases complete with spare fuses and spare electric fan. Price $149.50 net. FOB Bronxville, N. Y.

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1—450 KVA—3-60-13200-115/230 V. GE substation.
4—100 KVA—3-60-2400-208/120 V pyranol GE transformers with 225 A3 pole airbreaker mounted on case.
700 & 450 HP—180 rpm—4160 V UNUSED syn. motors.

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STEAM TURBINES
And Gear Reduction Units

1—Westinghouse 150 H.P. Steam Turbine and Gear Reduction Unit.
1—Westinghouse 100 H.P. Steam Turbine and Gear Reduction Unit.

These units are in excellent condition and priced reasonably. They are designed for inlet steam pressures of 105 and 90 lbs. respectively and 15 lb. back pressure. They can be used efficiently with higher initial steam pressure.

FS-2342, POWER
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1000 KW Mod 16-278A General Motors, portable
300 KW Mod 8-268A General Motors, portable
Model 16-258S General Motors, supercharged
Model 16-258 General Motors diesel engine
Model 12-567 General Motors diesel engine
Model 8-268A General Motors Diesel engine
We have considerable amount of good used parts for 16-278A GM engines, such as heads, liners, injectors, valves, Etc., also surplus accessories.

2—1250 HP Nordberg Mod T.S. diesel engines
2— 600 HP McIntosh-Seymore diesel engines
2— 360 HP F&M, Model 32 diesel engines
2— 240 HP F&M, Model 32 diesel engines
2— 120 HP F&M, Model 32-E-14 diesel engines
1— 60 HP F&M, Model 32 diesel engines
6—4000 cu. in G.M. Natural gas, 900 RPM
1—62½ KVA Buda Mod 1175 Diesel Gen. Set.
1—1500 KW G.E. Turbine Generating Set
1—500 KW G.E. Turbine Generating Set
2— 500 CFM Vacuum Compressors
1—6500 GPM 90' hd. Centri. pump w/150 HP motor
1—3500 GPM 90' hd. Centri. pump w/100 HP motor
1— 225 KVA G.E. Generator, 600 RPM
1— 500 KW G.E. Generator, 3600 RPM

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3—214 H.P. Fitzgibbons Horizontal return tube boilers, 125 lb. pressure, coal fired automatic stockers, vacuum pumps.
1—Fairbanks-Morse 250 H.P. diesel generating plant, switch gears and transformers.

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1250 KVA Westg., 3 ph., 60 cy., 480 volts, 1200 RPM, with 15 KW direct connected Excitor. Late modern steel frame & base unit. Complete with control gear.

125 VOLT DC GENERATORS

KW	Make	Speed
200	West.	900
150	Westg.	1200
150	Westg. (3)	900
100	Cr. Wh.	1200
100	E.M.	1200
100	G. E. (2)	900
100	Westg.	1200
100	Westg. (2)	900
75	G. E. (2)	1200
50	Westg. (2)	1150

PLUS 40 additional units ½ to 40 KW

250 VOLT DC GENERATORS

KW	Make	Speed
2000	G. E.	NEW
1150	G. E.	NEW
750	G. E. (2)	NEW
500	G. E.	500
400	G. E.	NEW
250	Cr. Wh.	1200
200	El. Mchy.	900
150	G. E.	1200
125	G. E. (2)	1200
125	E. D.	1750
100	Delco (4)	1150
75	Westg.	900
75	Cr. Wh.	1150
60	N. W.	1150
40	Rel.	1750
40	G. E. 3-Unit	1150
25	G. E.	1200
17	A-C	1750
15	Star	1750
10	G. E.	1150

PLUS 15 additional units ½ to 7½ KW

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NEW YORK 13, N. Y.

Est. 1910 44th YEAR

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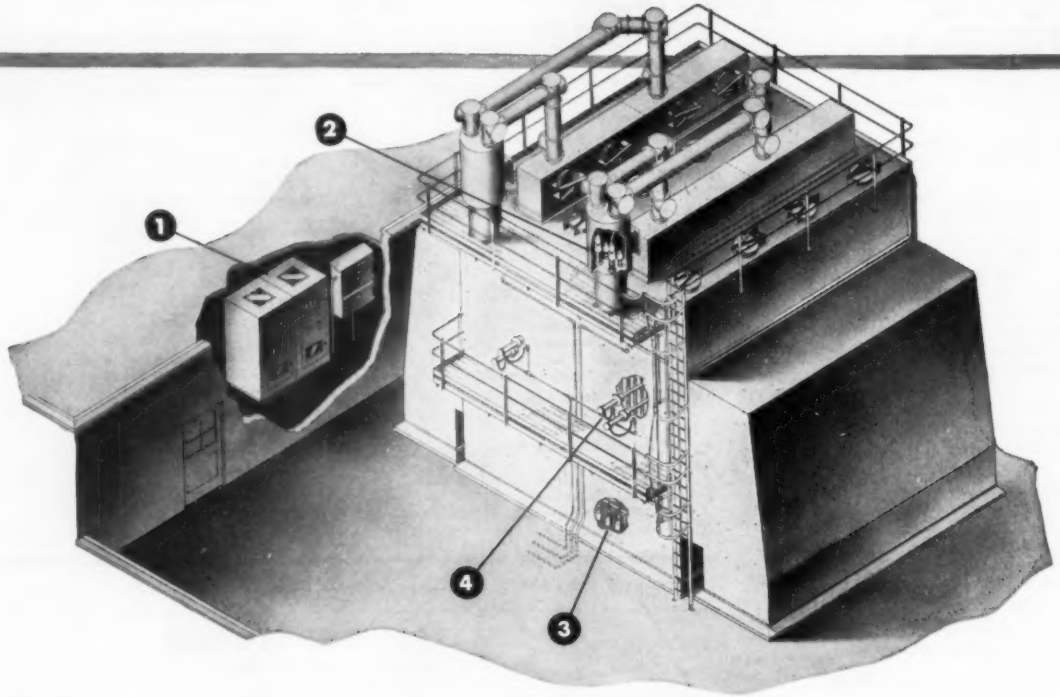
What's New in Electrical Precipitators?



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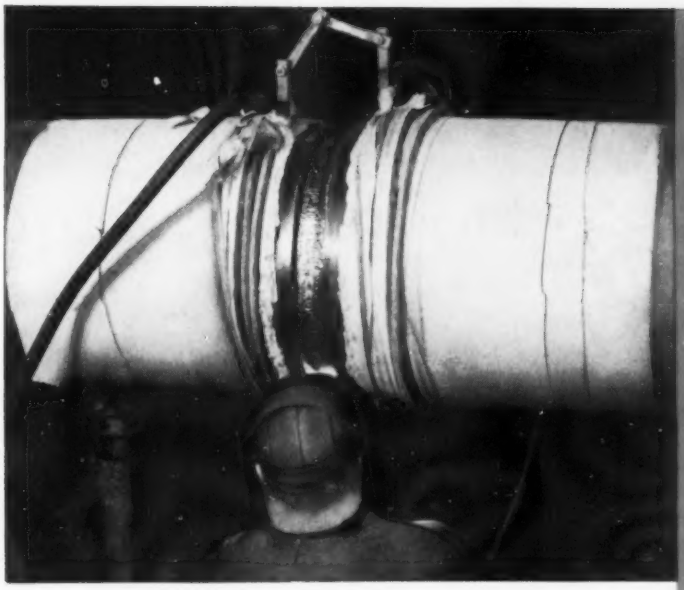

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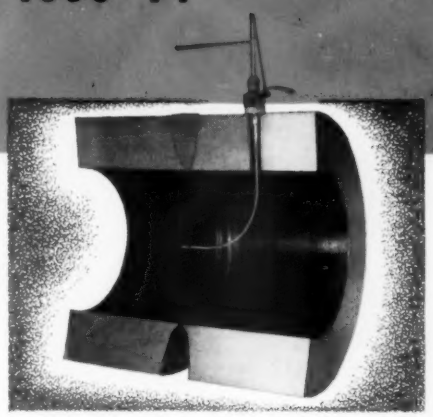

A test piece of 4" wall pipe cut apart to show the quality of the weld. Also illustrated is the method used to introduce a radium capsule into the center of a completed assembly for radiographic examination of the weld.

Taking photomicrograph of specimen of a test weld.

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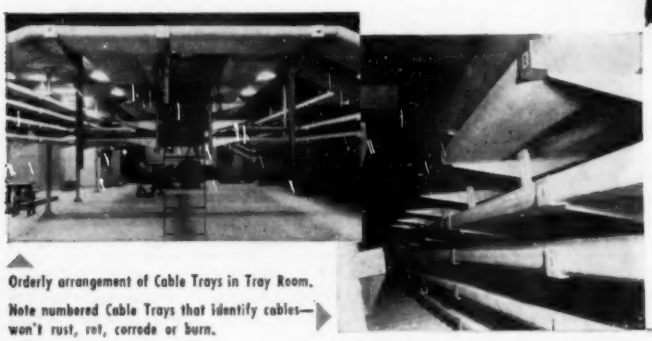

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